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ABSTRACT

In order to assess the effects of ambient contextual stimuli on retention, retro and proactive interference (RI and PI) seventeen experiments were conducted. In the retention experiments, the recall session was located in a context unlike the room used during original learning for one half of the subjects. In the inhibition experiments contextual changes were made between the usual three sessions of the RI and PI designs for the experimental groups. Retention decrements followed contextual changes when nonsense materials were used, but not when connected discourse or classroom materials were employed. When the second session (IL) in an RI experiment was located in a different context, improved retention resulted. In one PI experiment, a contextual effect was produced when session one (PL) was located in a different context but most of the PI experments did not produce interference when connected discourse or classroom materials were employed. (Author)

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&
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Provo, Utah

July 1969

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SUMMARY

There are several conflicting reports about the effects of specific ambient contextual cues on forgetting. In general it is hypothesized that a change in these contextual cues will result in more forgetting. In addition, there is some evidence that changing the contextual cues during the interpolated learning session will result in less retroactive inhibition. The above assertions have primarily been tested using nonsense syllables, and researchers have not tested the effects of contextual change on proactive inhibition. Accordingly, this project investigated the effects of contextual change on retention, retro and proactive inhibition. In addition, connected discourse and ordinary classroom materials have been employed.

The typical experimental design for the retention studies employed two basic groups. One group (AA) learned and recalled in the same context and the second group learned in one context and had the relearning occur in a context which was very dissimilar to where learning took place (AB). Other variables such as amount of original learning, length of interval, room used for the first session, sex, etc. were either counterbalanced or assessed using a factorial design. The retro and proactive experiments followed the basic design described for the retention studies but included room changes between the first and second and between the second and third session for the retroactive experiments. The proactive design employed up to two experimental changes; a change between the first and second session and also a change between the second and third. Each retro or proactive design included at least one of the above room changes and also appropriate control groups to test for inhibition.

A total of seventeen experiments were conducted. The results showed that contextual change produced a retention decrement when nonsense syllables were used but not when connected discourse or classroom materials were employed. A contextual change effect was found for retroactive inhibition when nonsense, connected discourse, and ordinary classroom material were used. Groups which received the interfering passage in a changed context performed more like control subjects during the recall session. The contextual effect was found only in one proactive inhibition experiment and this experiment used nonsense syllables. Most of the proactive experiments failed to produce proactive interference and thus the contextual change effect could not be tested.

The project, thus, has demonstrated a contextual change effect across different retention conditions and materials. Even though the contextual effects may not produce large differences in the amount of material forgotten, the pervasiveness of its influence seems apparent because ambient or specific environmental cues are present during all learning sessions but rarely are background cues completely reproduced during recall or interpolated learning.

The results presented in the report might be considered the only systematic attempt to investigate this phenomena of contextual change. Further research is urgently needed to develop procedures and to identify the variables which control proactive inhibition with connected discourse and classroom materials. Contingent upon successful demonstration of proactive inhibition with connected discourse, further investigation of contextual change effects should be undertaken using the improved procedures discussed in the project report.

INTRODUCTION

At least three major factors have been posited for forgetting or loss of retention of learned materials (Deese & Halse, 1967; McGeoch & Irion, 1952). By far the most heavily investigated factor has been that of interference. Here, response competition has been most frequently implicated. A second factor often posited to account for forgetting has been that of underlearning. This variable also has been widely researched although, due to the highly practiced nature of most contemporary studies of verbal learning, its influence often has been eliminated from systematic consideration. A third factor, focal to this proposal, is that of generalization decrement. While often cited as a potent variable, considerably fewer investigations of its effects and/or consequences have appeared in the literature.

Typically, generalization decrement has been thought to arise from a loss of set or from a change in contextual stimuli. As far as sources of decrement in forgetting are concerned, the traditional view has emphasized the principle of similarity between tasks. That is, similarity of task-relevant features between training and test conditions has been assumed to be critical. However, Irion (1948) has argued that a change in set or frame of reference occurring between the training and test conditions should be considered a potent contributor of generalization decrement. He introduced the concept of set to explain the uncontrolled forgetting which often occurs during the rest condition in pro- and retroactive inhibition experiments. After analyzing a number of studies, Irion (1948) pointed out that, while a certain amount of such uncontrolled forgetting can be accounted for by proactive inhibition from earlier, non-laboratory tests, a certain amount also can be due to a change in frame of reference between the conditions of original learning and those prevailing at the time of the retention test. Several experimenters in addition to that of Irion (1948) have confirmed this original observation (Jenkins & Postman, 1949; Postman & Postman, 1948), although others have not (cf. Adams, 1961).

Yet another fundamental source of generalization decrement, albeit less frequently mentioned, is that resulting from alterations in aspects of the external environment. While a very diverse and exhaustive experimental literature on stimulus generalization indicates that a change in stimulus conditions is almost always accompanied by decrement in the strength of learned responses, virtually all of these studies have had reference only to the focal features of the task or conditions. While everything learned is learned in response to stimulating or antecedent conditions which are a part of the learning situation and which are specific to it, learning also occurs in a complex context of environment conditions not specific to the particular acts being learned. There is the obvious external complex of stimuli impinging on the individual's exteroceptors, and there is the less obvious environment of intraorganic stimuli to the interoceptors. Indeed, in this latter regard, the influence of non-task, intraorganic stimuli upon learning in the infrahuman has been underscored in investigations by Girden & Culler (1937), Girden (1947), and Overton (1964). For example, in the latter instance (Overton, 1964), rats failed to emit correct responses in a test situation in which near-perfect learning previously had occurred under injections of pentobarbital. He further demonstrated that learning which had transpired either under the drug or non-drug conditions did not transfer to the opposite state, but could be re-instituted when the state under which the original learning took place was reproduced.

Overton's (1964) experiments provided impressive evidence for the role of intraorganic contextual support for forgetting. Here, the relevant background or contextual cues were provided from internal (beneath the skin) sources produced or altered by the drug injections. While both were non-specific and apparently irrelevant to the actual learning task, the presence or absence of these cues was the occasion for a pronounced alteration in retention and/or forgetting. That is, if they were present during training, their absence during testing was the occasion for a complete loss of memory, and vice versa.

The role of alterations of the external environment and performance decrements in infrahumans also has been demonstrated (Burch & McTeer, 1932; Carr, 1917). In one expecially impressive demonstration, contextual cues were found to interact with and to occlude manifestation of a fear-evoking conditioned stimulus (Anderson, Alleman, Merrill, & Dexter, 1967). Following stable barpress rates for food in an operant conditioning chamber, one group of rats was presented a to-be-conditioned (neutral) stimulus (CS). Another group of rats were similarly treated, but were not presented this stimulus prior to conditioning. These groups then were divided into two sets of two subgroups each. One subgroup from each of the preconditioning treatment conditions then was administered 10 pairings of the previously-presented CS with an abrupt, intense, electric shock in a different chamber. The remaining two subgroups (control groups) were administered shock (without CS presentation) in an otherwise identical procedure. Twenty-four hr. later all Ss were returned to the operant conditioning chamber, restabilized to bar-press, and then occasionally presented the fear-evoking CS on a non-response-contingent basis while they continued to work for food.

The results were striking. Those Ss who had received pre-conditioning, adaptation presentations of CS continued bar-pressing for food in the presence of this stimulus following the fear-conditioning treatment. That is, these Ss did not suppress their response rates to the normally fear-evoking event. In contrast to this, those Ss who had not received pre-conditioning presentations of the CS exhibited complete suppression of response rates in the test situation in its presence. A most surprising additional finding was that those rats who did not suppress in the bar-press situation to the fear-evoking CS exhibited pronounced behavioral indices of fear to this stimulus when tested in another environment in which it had not been presented prior to conditioning as part of an adaptation procedure.

These two studies (Overton, 1964; Anderson, et al., 1967) provided impressive evidence for the role of both intraorganic and external contextual support for forgetting on an infrahuman level, although the interaction between background stimulation and learning in the latter case was considerably more complicated than in the former. Here, the contextual cues were those of the ambient background or environment. These authors reasoned that the pre-conditioning adaptation presentations of the CS, which were non-contingent upon S's ongoing bar-press behavior, taught S that this stimulus was to be considered an irrelevant feature of that pre-CS presentations that this stimulus was to be ignored when presented against the background features of the operant conditioning environment. Hence, following fear-conditioning to the CS elsewhere, its re-introduction into the operant environment did not occasion bar-press suppression because of its prior learning with regard to the background cues. However, since this learned contextual interaction was relevant only to the non-specific features of the operant chamber, CS presentation in any other situation was found to have its normally-expected potent effects on the behavior of these same rats. Hence, it was argued that some sort of incidental contextual discrimination had been learned.

Evidence for contextual support in human learning, although neither systematic, consistent, nor extensive, has been reported. The results, even though incomplete and occasionally contradicting, are however intriguing and provocative. Some decrement from changed stimulus conditions in human learning studies apparently can provide quite a difficult problem for analysis. In one study, closely related to the problems suggested for investigation by this proposal, Ss learned paired associates in which each pair was presented on a card of a different shape and color (von Wright, 1959). The Ss were later tested for recall with the associates either presented on the same cards or on cards of a uniform gray. In support of an earlier finding by Dulsky (1935), the change to the uniform card always led to a decrement when the original cards were returned. While the contextual variable in this study (von Wright, 1959) was more proximal to the task operations, the parallel between this finding and our preceding remarks is apparent. Namely, retention loss can result from a change in external context, thus implicating such as an important feature in accounting for forgetting phenomena. Interestingly, the experiments of Dulsky (1935) and von Wright (1959) were the only ones we found in the literature in support of the widely-held notion that retention functions can be dependent upon ambient background support. Nevertheless, there are more reports of altered context without decrement in retention (Farnsworth, 1934; 1937; Pessin, 1932; Reed, 1931). More will be said of this later.

There appear to be even fewer human studies involving contextual influences when more complex paradigms are utilized. Bilodeau &

Schlosberg (1951) focused on the similarity of ambient stimulating conditions as a variable in a verbal learning study involving retroactive inhibition (RI). Arguing that interference, exerted by interpolated activity upon the recall of original material, represented a major explanatory construct in accounting for retroactive inhibition, these authors asserted that the greater the similarity in background between the original and interpolative learning, the more difficult it should be for S to discriminate between the two sets of materials and, hence, the greater the retroactive inhibition. While acknowledging that such had been adequately demonstrated for similarity between the actual materials, their concern pertained to the less obvious role of similarity of so-called incidental stimulation. Interestingly, their study also was proposed, in part, because Nagge (1935) had reported that incidental stimulation was not influential in an RI experiment.

Bilodeau & Schlosberg (1951) repeated Nagge's (1953) study. The original learning took place in what the investigators described as a "drum room--a dingy storeroom filled with old apparatus. The S stood as he attempted to learn the material presented on a memory drum. The learning of the interpolated material for the first group was done in a room identified as the "card room"--a room made as different as possible from the room in which the original learning transpired. The card room was a large basement classroom in which the material was presented on a card-flipping device similar to a desk calendar. The Ss sat in front of the apparatus, and E flipped the cards every 2 sec. A second group learned the interpolated material in the same room where the original learning took place. A third group's interpolated activity consisted of doing long-division problems for 8 min., also in the original learning room. Following the interpolated activity, all of the groups relearned the original material in the drum room. In a second experiment the original learning took place in the card room, and the drum room was used for the interpolated learning for one of the experimental groups.

The findings revealed that the control group showed the best recall. The primary concern, however, was the comparison of the experimental groups. The group which learned the interpolated material in the environmental setting different from that in which the original material was acquired recalled the original material significantly better than the second experimental group (which learned the original and interpolated material in the same room). Greespoon & Ranyard (1957) confirmed these findings. Indeed, the experimental group in their study who received the interpolated learning in the different environment exhibited test performance almost identical to that of controls who had had no interpolative training.

Interestingly, these few human and animal studies apparently assume the major experimental support for the widely-held notion that changes or alteration in contest (i.e., background or ambient stimulation) can markedly alter retention and/or learning functions.

Further, there appears to be little or no follow-through in establishing the boundaries and/or range of conditions under which this non-specific, ambient background stimulation is most or least effective as a variable for retention and forgetting. This hiatus of research, contaminated with occasional negative or opposite findings (cf. Birnbaum, 1966; Farnswroth, 1934; Nagge, 1935; Pessin, 1932; Saltz, 1963; Reed, 1931), underscore the need for a systematic and comprehensive experimental program designed to evaluate the effects of contextual change on retention, proactive and retroactive inhibition, and facilitation. The research outlined in this report is intended to systematically investigate contextual effects on retention, and retro- and proactive inhibition. It will initially focus on serial learning using nonsense syllables, then serial learning using connected discourse, and finally actual classroom experiments.

Postman (1963) has commented upon the problem of retention under ordinary circumstances. He has asserted that, because of the better internal organization of materials encountered in everyday situations, one might expect that forgetting in the laboratory would be greater than for things learned outside. Indeed, if his analysis is correct, one might predict that the acquisition and retention of everyday materials would be less dependent upon the support of the external milleau. That is, such materials inherently may contain sufficient discriminative cues so as to minimize the need for associations with the external ambient features of the environment for their retention as well as to resist the interfering effects of related interpolated activities.

Another point to be considered in generalizing from the laboratory to conditions of ordinary experience is that laboratory material is usually very highly practiced. In ordinary experience one seldom learns things by rote memory. In reconstructing a passage from a history text for purposes of examination, for example, one seldom attempts a verbatim restatement of the passage. Therefore, by the standards of the laboratory, practice for what we learn in school is often very limited. Indeed, since it is a well-established law that the forgetting curve partly depends upon the strength of the habit at the end of training, much of what seems to be forgotten in daily life is probably the result of minimal learning in the first place.

These preceding two paragraphs are presented as justification for concern regarding extrapolation of laboratory findings on contextual effects to the classroom. Further, since generalizations from laboratory experiments to the classroom represent an enormous leap due to a geometric increase in complexity, it initially might be more properly conservative to examine contextual influences in less complicated situations which, nevertheless, may represent at least a portion of that which transpires in the school room. Such an approach is exemplified by McGeoch & McKinney (1934), Deese & Hardman (1934), Hall (1955), Ausubel, Robbins, & Blake (1957), and, more recently, in a series of studies by Slamecka (1959; 1960; 1960a; 1961; 1962). In virtually all of these studies the focus was upon the demonstration of retroactive and proactive inhibition on connected discourse, the latter materials being more representative of that encountered in classroom and everyday situations. Hence, while preserving a basic laboratory atmosphere, materials more germane to ordinary situations were employed as part of traditional verbal learning paradigms.

In one study (Slamecka, 1960) a single sentence of 20 words was employed. An example of such a sentence is as follows: "We must postulate that from strictly semantic points of vantage, most confusions in communication revolve about inadequate stipulation of meaning." Sentences of either high, intermediate, or low similarity to the original material were used for the interpolated activity. The high-similarity passage dealt with the topic of semantics the intermediate-similarity passage with mathematics, and the low-similarity passage with government. All learning was by the method of serial anticipation, each word being presented at 3-sec. rate and with a 6-sec. intertrial interval. Both the original and interpolated passage were learned to a criterion of one perfect trial. The time between the end of the original learning and the start of the relearning of the passage was held to a constant at 12 min., 6 sec. Retroactive effects were obtained for all work groups, with the group receiving the high-similarity interpolated material exhibiting the poorest recall scores, followed by the intermediate group, and then the low.

In a second study, Slamecka (1961) demonstrated that connected-discourse material also was susceptible to proactive inhibition. In yet a third study, Slamecka (1960a) investigated retroactive inhibition as related to the degree of interpolated and original learning. Again, the result supported the findings obtained when more traditional verbal learning paradigms and materials were employed. He showed that the recall of the first passage depended upon the degree of similarity to an interpolated passage and upon the degree of first-passage practice.

Furthermore, von Wright (1959b) was able to show that an interpolated recall of part of a prose passage had a demonstrable interfering effect on the later recall of the remaining portions of the same material. King & Tannenbaum (1963) have generally confirmed the findings of Slamecka (1960) when using group learning situations in which there was unlimited time for written recall.

While use of prose and other more meaningful passages as materials in a human learning study better approximates classroom and ordinary situations, these studies nevertheless preserve the artificiality of the laboratory situation. A careful analysis of the procedures of Slamecka indicated that great care was taken in controlling for incidental and other extraneous features. Further, the material was highly practiced, again resembling more the laboratory than the schoolroom. Thus, with the exception of King & Tannenbaum (1963) and possibly Abernathy (1940), in which similar procedures were employed for groups and more relaxed testing conditions prevailed, the question of extrapolation into an actual classroom situation remains germane and important. Hence, given success in producing a body of lawful relationships between contextual influences and certain verbal learning processes, we envision, as a next step, actual classroom research. Here again, many of the same variables mentioned in the preceding sections appear relevant for study.

In overall perspective, then, we have presented sketchy but intriguing evidence from the infra- and human laboratory that contextual effects may markedly interact with retention and acquisition functions. Because of the sketchy and nonsystematic nature of most of the research in this area, considerable laboratory experimentation will still be needed. Here, it is noted that the laboratory provided the most convenient and controlled setting for experimental examination of such variables as intervals between training and testing, meaningfulness, etc. It further was suggested that, because the more molar purpose of the present report was extrapolation, the role of contextual interactions should be investigated when the learned materials represented those more often encountered in ordinary situations. It also was pointed out that use of such materials introduced the problem of increased internal organization, a variable thought likely to reduce the importance of contextual support.

Scope

Interestingly, while receiving almost no systematic investigation, speculation upon the wide-spread effects of contextual or background stimuli upon perceptual and learning phenomena received frequent mention in psychology. The literature is replate with both anecdotal and occasional experimental reference to its role and its effects. For instance, early perception studies successfully employed background or contextual stimuli to conceal figures and objects which were otherwise easily identified by the S. Here, even after repeated exposure to such figures, embedding them within a camouflage of other materials often served to "confuse" or "deceive" S from correct identification.

John (1967), in a discussion of state dependent memory, points out the often stated importance of contextual effects and the lack of conclusive evidence for the phenomena. "The observations indicate that the total stimulus complex, including date from various sense modalities providing information about 'ground' as well as 'figure' possesses cue value for the organism. Although such casual information is admittedly far from conclusive, it suggests that a fairly complex multiple set of input requirements must be satisfied for a conditioned response to be elicited upon stimulus presentation.

The role of contextual effects also was important in resolution of the place vs. response learning controversy of the 1930's. Here, so-called "crucial" experiments in support of the more cognitive place-learning position were often found to be the result of uncontrolled background cues which had served to "guide" or "steer" the S to its respective, reinforced destination.

Not to be neglected has been the recent emphasis upon the generalized role of stimulation for both adequate biological and psychological early development and for maintenance of stable behavior patterns in adulthood. Here, for example, exposure to so-called "enriched" environments (i.e., environments replete with a varied and complex contest) during infancy have been found to augment acquisition of habits in adulthood. Further, there have been several reports regarding "optimal" human performance under conditions of different degrees of complexity and background stimulation (cf. Leuba, 1955).

Another highly relevant approach which has explicitly embodied the role of background or contextual stimuli to explain behavior has been that of Helson (1959). Here, background or contextual effects have been viewed as potent determiners of set or frame-of-reference. Helson and his students repeatedly have demonstrated that systematic introduction of such events as interpolated stimuli, asymetrical background stimulus configurations, etc. can profoundly influence judgements involving weight, color, and spacial discriminations.

These and other views have led to the apparent wide-spread, yet undocumented, speculation that recall for ordinary learning materials is best facilitated under conditions of transituational contextual constancy. Indeed, even though rarely referenced, this speculation can be found in a variety of diverse publications. For example, Frandsen (1961), in a textbook on educational psychology, has stated, without bibliographic reference, that "concepts and skills learned in a particular setting are sometimes recallable in a different situation. When some of the cues guiding the original learning are absent...the once remembered concepts or skills seem to be forgotten." Further, Guthrie (1935) appears to have embraced this principle in his contention that maximum response strength can only be predicted if all of the cues present at the time of original learning are again restated at the time of testing. While not specifically alluding to ambient or background stimuli, it is apparent that Guthrie intended to implicate all possible sources of stimulation, even those which might, by some standards, be considered irrelevant environmental features. Indeed, in a considerably more sophisticated version of Guthrie's earlier speculations, Estes (1958) has taken great care to explicitly implicate the role of non-task-relevant features of the external environment in his more general behavioral theory.

REPORT OF FINDINGS

Before summarizing our present research findings, it might be convenient to organize them with regard to the dimension of complexity of the design and procedure. Perhaps the most straight forward of the studies to be presented are those which dealt with the simple retention of learned materials. The general paradigm for these simple retention studies involved an experimental and control group, the latter of which learned materials in one setting that subsequently were either relearned or recalled in a highly different environment. Control Ss both learned and relearned these same materials in the same environment. While several additional variables besides that of contextual change were introduced, these studies primarily were concerned with (a) whether differences in relearning occurred between the experimental and control Ss, and (b) whether these differences, if any, were a function of the kind of materials that were learned or length of the retention interval. With regard to kind of materials, both nonsense syllables, connected discourse, and regular classroom materials were employed across the several paradigms that were investigated. Hence, the initial portion of our progress report is devoted to a discussion of simple retention studies which, in order of presentation, involved the use of nonsense syllables, connected discourse materials, or regular classroom materials.

In general, it was predicted that experimental groups should exhibit poorer retention than controls. This prediction was based on the assumption that the original learning not only involved the acquisition of stimulus response associations within the material, per se, but also between the material and the specific background stimulating circumstances that existed at the time of acquisition. Thus, remaining in the environment in which original learning (OL) occurred would result in a greater number of stimuli which were associated with the learned materials and, hence, which could be utilized by S in order to evoke appropriate recall of the original connections. In contrast, an alteration in background stimuli would result in a reduction of available connections which might assist S in recalling the originally-learned events. This latter prediction was based upon the principle of generalization decrement which operated on the assumption that recall and relearning are better when conducted under circumstances similar to those which prevailed at the time of OL.

The second portion of this progress report is devoted to an elaboration of the effect of contextual manipulations using retroactive inhibition (RI) paradigm. Use of an RI paradigm results in the introduction of additional factors which make interpretation of the data considerably more complex than when a simple retention paradigm was employed. Again, two basic groups typically were employed in these studies. The experimental group initially was trained to learn a set of materials to a given criterion in a highly distinctive environment. These Ss then were transferred to a highly dissimilar setting where they learned a presumably interfering set of materials (i.e., interpolated learning (IL)). Upon return to the original distinctive environment, experimental Ss were asked to relearn the original set of materials. The relearning performance of these Ss was contrasted with controls who either learned the initial two sets of materials in the same environment or who had no IL at all. Again, while a number of other variables often were manipulated in these studies, it was considered of primary importance to determine whether the contextual variable was equally effective (if at all) when nonsense, connected discourse, or regular classroom materials were employed.

In contrast to the simple retention studies, it was predicted that experimental Ss in the retroactive inhibition (RI) experiments would exhibit more rapid relearning proficiency than controls. The reason for this prediction was that the normally-interfering effects of the interpolated learning would be reduced for experimental Ss since the latter transpired in an environment which was distinctively different from that in which the materials-to-be-learned initially were acquired. With less contextual-stimulus support for the elicitation of the interpolated materials during relearning, the reacquisition of the original list should be less impeded than for controls. Put another way, the acquisition of interfering interpolated materials in an environment distinctively different from original learning should result in greater generalization decrement with regard to the interpolated materials when S is relearning the original events. For control Ss, there should be little or no generalization decrement with regard to background stimuli between the interpolated and relearning tasks.

The third portion of this progress report is devoted to an exposition of studies which employed a proactive inhibition (PI) paradigm. Again, the two groups of greatest concern were an experimental group, who received prior learning (PL) in a setting different from OL and RL, and a control group who received prior, original, and relearning all in the same setting. Actually, additional variations were possible with regard to this paradigm. For example, prior and original learning might be conducted in the same environment for a given experimental group, and relearning could transpire in a distinctively different setting. A third variation involved a change in background settings both between PL and OL and between OL and RL. These various combinations and permutations of the proactive inhibition paradigm, as in the preceding studies, were applied to nonsense, connected discourse, and regular classroom materials.

As might be expected from the increased complexities introduced by the PI design, all predictions in these studies reflected a commensurate parallel increase in complexity. To take but a single example in which the background stimulating conditions were changed only between prior and original learning (but preserved between original and relearning), it was predicted that experimental groups would exhibit better scores on the relearning task than controls in this particular circumstance. Since PL occurred in a distinctively different environment for the experimental group, greater generalization decrement would result thus reducing any proactive interfering effects of these materials in subsequent original learning or on the relearning task. Since prior, original and relearning would all occur in the same environment for controls, the lack of generalization decrement would allow the PL materials more opportunity to proactively compete with the relearning task. Obviously, these predictions were altered when the background change occurred between original and relearning or between all three phases of the PI paradigm.

Retention

The experiments which are now reported are listed sequentially in order of complexity. First, retention, then RI and finally PI experiments are presented. Within each of these three categories the experiments using nonsense materials are presented first, then connected discourse and finally classroom materials.

A number of abbreviations are frequently used in describing the following experiments and are now summarized for the convenience of the reader.

PI = Proactive Inhibition
RI = Retroactive Inhibition
PL = Prior learning and session 1 in PI design
OL = Original learning session 2 in PI design or session 1 in RI design
RL = Relearning or session 3 in PI and RI design
IL = Interpolated learning and session 2 in RI design
TC = Number of trials to criteria
NCFT = Number od correct anticipation first trial during experimental session
NEFT = Number of errors on the first trial during each experimental session
*S*s = Subjects

Experiment I - Retention One-Hour Interval

Subjects.--The subjects were 64 students enrolled in psychology courses at Brigham Young University. The students in these courses were required to participate in psychology experiments as a part of the course requirement. An equal number of male and female subjects were used. The subjects were naive with respect to the purpose of the experiment.

Apparatus, Materials, and Room Environments.--The following of ten low-to-medium-association nonsense syllables was prepared from Glaze's (1928) list of nonsense syllables: WUQ, RAJ, XEP, JIR, QAZ, BEH, XAK, YIX, JAT, CIY. The list was typed in elite capital letters on white paper and placed in four memory drums. The mean association value of the syllables was 39.3.

The experimental conditions were derived from four different room environments. Room A was prepared to resemble a quiet reading or stereo room in a home or public building. The room dimensions were 8 ft. x 12 ft. x 8 ft. The walls were painted a light green, the ceiling was white acoustic tile, and the floor was a light-tan tile. A window into a hallway was covered with light beige drapes. (The drapes were always drawn.) A number of popular magazines were lying on a small coffee table that sat along one wall. A large green arm chair was situated in one corner of the room. Two white vinyl chairs sat against two of the walls facing the center of the room. A large brown easy chair was situated toward the center of the room as though it had been drawn from its regular place in one of the corners. This chair was later pulled in front of the memory drum for the subject to use while he learned the list of syllables. A small study desk covered with a light-green table cloth sat in front of the window. A table lamp with a red shade was sitting on one end of the desk. In the front center of the desk was a small (1 ft. x 1 1/2 ft.) red box. In the middle of the box, a window was cut to match the window of the memory drum. The memory drum was placed behind the box cover, the three different colors of paper were used to cover the small part of the memory drum that could be seen by the subjects. All of the light, during the learning and recall trials, was from a 40-watt bulb in the desk lamp. A tape recorder, placed behind the corner arm chair, was playing soft instrumental music. A travel poster and a framed picture hung on two of the walls, and a small potted plant sat in another corner of the room. Subjectively, the room atmosphere was judged to be very warm and pleasant.

Room B was prepared to be the sister room to Room A. Room B was a basement storage room (12 ft. x 12 ft. x 10 ft.). The walls and ceiling were painted black. Large black pipes and air ducts also ran across the ceiling. The floor was cement. The door was covered with black oil cloth. One wall was lined with cupboards that were also painted black, and a set of black shelves sat in one corner of the room. A large structure that looked somewhat like a pilot's cockpit sat against one wall, and a large drum structure sat next to the "cockpit." The rest of the room was packed with chair-desks that were sitting on the floor. This made the room rather crowded. A closed tape recorder was lying on one of the desks next to the cockpit and drum, and an unmodified memory drum sat on top of the tape recorder. Papers, boxes, other small objects, and psychological apparatus sat on the cupboards and shelves. Four fluorescent lights hanging from the ceiling made the room brightly lit. A sun lamp with a 40-watt incandescent globe sat on top of the cupboard and was also turned on. The light was cast toward the memory drum. A dull hum from a nearby furnace was clearly audible. Room B was judged to be very different in atmosphere from Room A. Rooms A and B were paired for half of the subjects who changed room environments for their retention tests. Rooms C and D were paired for the other half of the experimental subjects.

Room C was a fairly small (8 ft. x 14 ft. x 8 ft.) conference-type room that was prepared to look as though it was decorated for a party or small banquet. A bright-red table cloth covered a large table that was situated in the center of the room, and many chairs surrounded the table. Bright-red curtains were hung over the bottom fourth of the windows that composed the top half of one of the walls. The venetian blinds over the top three-fourths of the window were open, and daylight illumination entered the room. The fluorescent lights in the room were also turned on in order that the room would be very brightly lit. A chalkboard on one wall was covered by a travel poster and bright-red curtains. A large framed painting hung on the opposite wall. The walls were a light green, the ceiling was white tile, and the floor was tan floor tile. A black box sat at one end of the table with a small hole that matched the window of the memory drum. The memory drum window was surrounded by colored paper. A colorfully decorated valentine card box sat in the center of the table. Soft instrumental music was played by a tape recorder that was sitting on the floor where it could not be seen by the subject during the learning trials.

Room D was the sister room to Room C. It was small (8ft. x 4 ft. x 10 ft.), and all of the paraphernalia which was piled in the room made it very crowded. The walls, floor, and ceiling were cement . Black and orange pipes and an air duct ran across the ceiling. A sound-proof booth, whose door opened into Roon D, formed one of the walls to Room D. The booth wall was cream-colored. When the booth door was open, the single incandescent bulb in the booth made sufficient light for the nonsense syllables to be well illuminated, but Room D was otherwise quite dark. A table sat at one end of the room and was stacked with boxes and other materials. A small desk was placed by the booth door, and what looked like an old short-wave radio receiver sat on the desk. An unmodified memory drum sat on top of the radio receiver. Other wierd-looking objects that had been used for psychological experiments were lying on the floor, on the table, and inside the booth. A hum from a nearby furnace was clearly audible. The atmosphere of Room C was judged to be very bright and fun, while the atmosphere of Room D was judged to be rather depressing and enclosed. The contrast between Rooms C and D was judged to be extreme.

Design.--A straightforward retention experiment was conducted with the main experimental factor being room-environmental-conditions-at-recall. Letting A stand for any of the four rooms and B for its sister room, two basic conditions were treated: learning in A and recalling in A (AA), and learning in A and recalling in B (AB). To control for possible differences in room effects on learning, an equal number of subjects were given original learning in each of the different rooms. Thus, four control and four experimental groups were formed: AA, BB, CC, DD, AB, BA, CD, DC. One other condition was treated within this basic design: amount of original learning. Half of the subjects in each of the eight room conditions learned the list to one complete repetition (all ten syllables correct), and half of the subjects were stopped in learning when they achieved six correct responses on a given trial. Since the four rooms were completely crossed with the two levels of the amount-of-learning factor, and since both the room factor and the amount-of-learning factor were completely crossed with the two levels of the room-environment-at-recall factor, the experiment was a complete factorial design. Since the requirements of random assignment and equal cell n were observed, the experiment was also an orthogonal design (Hays, 1965, p. 393). This design allowed the various treatment effects and the interaction effects to be estimated and tested separately since all of the potential information in the data was separated into distinct and non-overlapping portions (Hays, 1965, p. 408). Also counterbalanced across all conditions were male and female subjects and different experimenter participation. Subjects were solicited from psychology classes and were randomly assigned to groups as they appeared for the experiment. It was assumed that for the task employed in this experiment, this sampling procedure could be considered adequate to approximate the statistical requirement of the sample bring drawn randomly and independently from the opulation of psychology students at Brigham Young University.

Procedure.--Each subject was trained and tested individually. The subject was ushered into the room and read a set of standard instructions. The method of serial anticipation was used. The subjects were asked to spell aloud each syllable before it appeared in the window. Syllables were presented for two seconds with approximately four seconds between syllables and a twenty-second inter-trial interval. The list was repeated until the subject reached the designated criterion level for his amount-of-learning condition. In Rooms A and C the subject was seated in front of the memory drum, and the experimenter sat behind the subject and recorded his responses. In Rooms B and D, the sister rooms of A and C, the experimenter stood in front of the subjects and recorded the responses, and the subjects stood during the training and testing trials rather than sitting as in Rooms A and C. When the subject reached the criterion, he was led from the room and allowed to go wherever he liked to go and do whatever he wanted to do for the next 50 min. He was instructed not to practice or not to try to remember the list during the interval. After the retention interval elapsed, the subject was taken to the appropriate room, and the relearning trials were given immediately following the recall instructions. Both the recall and relearning methods were used to test for retention (Mednick, 1964). The number of correct responses on the first relearning trial was recorded, and the subject was then given as many additional trials as necessary for him to relearn the list to his designated criterion level. A record of correct responses for each trial during learning and relearning was kept.

Results

Since the experiment was expressly designed to test whether the retention scores of the experimental subjects (AB groups) were significantly poorer than the scores of the control subjects (AA groups), a directional t-test was employed to test the difference between the means of the experimental (change) and control (no change) subjects. Analyses presented in Table I reveals that no significant differences in room-effects were present for either retention performances. The AA, BB, CC, DD groups were combined in computing the means for the experimental subjects. Because it was of interest to test directly for the contextual-change effect for both the overlearning subjects and the underlearning subjects, the overlearners and the underlearners were tested separately. Since retention was measured by both the recall and relearning methods, two separate retention-test analyses were made on the same subjects. Both the number of syllables recalled correctly on the first relearning trial (NCFT) and the number of trials required to relearn the list of syllables (TC) to criterion were analyzed.

TABLE I

MEANS AND t RATIOS FOR RECALL (NUMBER CORRECT FIRST TRIAL RL) AND RELEARNING (TRIALS TO CRITERION RL)

Variable	100% Criterion OL			60% Criterion OL		
	Experimental n=32	Control n=32	t	Experimental n=32	Control n=32	t
Recall (NCFT) MS error=4.3	7.44	7.50	.071	4.31	5.44	2.073**
Relearning (TC) MS error=0.6	3.81	2.75	1.721*	2.62	1.75	2.621***

* p < .05
** p < .025
*** p < .01

Table I shows that the performance of the no change group (controls) was superior to the experimental group. The 100% OL Ss who changed required more trials to reach the relearning criterion difference was significant on both measures.

One important question was whether the degree to which the list was learned made a significant difference in the size of the effect caused by changing environmental conditions. Hence, a second primary interest in the data analysis was the test for interaction between the environmental-conditions-at-recall factor and the amount-of-learning factor. To equate the overlearning subjects with the underlearning subjects on the relearning measure, it was necessary to measure the number of trials required to relearn the list to a criterion of sixty per cent correct for the overlearning subjects (i.e., six out of the ten syllables correct). Another question concerned possibled room-change differences. Since four room-environments were used which differed in many ways, and which presented what appeared to be differences in the amount-of-contrast effect produced by the room changes, a third interest in the data was whether the effects caused by certain room changes were significantly different from the effects caused by other room changes. Therefore, the three-way interaction test was of interest to determine whether the contextual change effect varied as a function of amount-of-learning and particular room-change contrasts. To test these possible interactions, a three-way analysis of variance (fixed effects model) was employed(Myers, 1966, p. 81).

As is clear from Table II, the contextual change effect for the number correct on the first relearning trial did not vary significantly as a function of the amount-of-learning levels (A x C). Also, the test for the Rooms x Conditions-at-recall (A x B) interaction was insignificant.

The case was somewhat different, however, for the retention measure based on the number of trials necessary to relearn the list to a criterion of six correct (Table III). In this case the interaction test (A x C), and the direction of the difference, reveals that the contextual-change effect was significantly greater for the underlearning subjects than it was for the overlearning subjects, $F\ (1.48) = 4.738$, $p < .05$. This result may have been due to the ceiling effect that resulted for the overlearners, when the criterion of six-out-of-ten was used in this analysis. Two Rooms x environmental-conditions-for-recall interation, and the three-way interaction tests were again insignificant.

TABLE II

SUMMARY OF THE ANALYSIS OF VARIANCE OF RECALL (NCFT) SCORES

Source of Variation	Degrees of Freedom	Mean Square	F Ratio
A (Change vrs. No Change)	1	5.6	1.326
B (Room for OL)	3	5.6	1.326
C (Amount of Learning)	1	107.6	25.023
A X B	3	3.9	0.914
A X C	1	4.5	1.061
B X C	3	1.1	0.268
A X B X C	3	5.7	1.335
Error	48	4.3	

TABLE III

SUMMARY OF THE ANALYSIS OF VARIANCE OF RELEARNING (TC) SCORES

Source of Variation	Degrees of Freedom	Mean Square	F Ratio
A (Change vrs. No Change)	1	3.5	5.83
B (Room for OL)	3	1.3	2.421
C (Amount of Learning)	1	15.0	25.00
A X B	3	0.5	0.850
A X C	1	2.6	4.738*
B X C	3	0.1	0.252
A X B X C	3	1.2	2.121
Error	48	0.6	

*$p < .05$

Experiment II - Retention One-Week Interval

Experiment II was designed and conducted exactly in the same manner as Experiment I. The only differences were that a different group of 64 subjects was used, and the retention interval was one week rather than one hour.

Results

The exact same questions were of interest in Experiment II, and the same data analyses and tests were made for experiment II as were made for Experiment I. Table IV presents the means and t ratios for the change verses no change groups.

No significant contextual change effects were found for the one-week interval. The overlearners recalled more information and also required fewer trials to relearn than the underlearning subjects.

The interaction analysis for Experiment II were presented in Tables V and VI. As can be seen from these tables, none of the interaction tests for the one-week interval subjects were significant.

TABLE IV

MEANS AND t RATIO FOR ONE-WEEK RETENTION INTERVAL

Variable	100% OL Ss			60% OL Ss		
	Experiment n=32	Controls n=32	t	Experiment n=32	Controls n=32	t
NCFT MS error=5.6	4.31	4.62	.38	2.56	2.75	.244
TC MS error-2.0	1.9	1.9	0.0	3.69	2.62	1.65

TABLE V

SUMMARY OF THE ANALYSIS OF VARIANCE OF RECALL (NCFT) SCORES

Source of Variation	Degrees of Freedom	Mean Square	F Ratio
A (Change vrs. No Change)	1	1.0	.178
B (Room for OL)	3	1.4	0.246
C (Amount of Learning)	1	52.6	9.392
A X B	3	4.8	0.784
A X C	1	0.1	0.011
B X C	3	3.9	0.705
A X B X C	3	2.4	0.422
Error	48	5.6	

TABLE VI

SUMMARY OF THE ANALYSIS OF VARIANCE OF RELEARNING (TC) SCORES

Source of Variation	Degrees of Freedom	Mean Square	F Ratio
A (Change vrs. No Change)	1	4.5	2.2
B (Room for OL)	3	2.7	1.358
C (Amount of Learning)	1	21.4	10.70
A X B	3	0.8	0.403
A X C	1	3.5	1.758
B X C	3	1.2	0.590
A X B X C	3	0.1	0.029
Error	48	2.0	

Experiment III - Retention Among 6 Age Levels With a 24-Hour Interval

Subjects.--The subjects were 288 students attending a public school. The subjects were selected from grades two, four, six, eight, ten, and twelve; with each of these grades having 48 students. The age range for the subjects were from seven years to eighteen years, there were equal number of male and female subjects. The subjects were naive with respect to the purpose of the experiment.

Apparatus, Material and Room Environment.--The following list of eight nonsense syllables were used from Archer's list: BUL, DIK, GOP, LAC, ROG, WEN, JUT, VEX. They were selected at the 90% level of difficulty or meaningfulness. None of the list had the first or last letters alike and only two had two vowels alike.

The experimental conditions were derived from two different rooms. Room A was prepared as much as possible to look like a relaxed study room. The measurements of the room were small, 4 feet by 6 feet. It was constructed by putting folding partitions up against one solid brick wall. The partitions were lined with paper and painted purple, each wall was decorated with a colorful picture framed in white. On the floor was decorative green throw rugs and the chair used by the subject was a large soft padded swivel chair. In front of the subject was placed a memory drum that was set in a box, the box was covered with contact paper with decorative large yellow flowers. A slit had been cut in the top of the box to reveal the nonsense syllables. To the left of the subject was placed a coffee table on which a lamp and flower arrangement had been placed. Besides the lamp on the coffee table there was a lamp placed in front of the memory drum and also an overhead light that made good lighting for the subjects. The memory drum was on an end table in fron of the subject.

Room B was the other experimental condition. It consisted of a very large art room measuring 42 feet long and 18 feet wide, measuring very high with a slant roof design, the lighting was excellent with overhead windows and very bright florescent lights. The art room had four very large red tables placed in it measuring 2 feet by 9 feet. The room had metal folding chairs at all the tables, a green counter to the far side measuring 2 feet by 24 feet. A bare memory drum was placed in the center table in the center of the room. The subject was required to stand in front of the memory drum.

Design.--Each class of 48 subjects was randomly assigned to one of the four groups for each grade level. A straight forward retention experiment was conducted with the main experimental factor being room environmental condition at retention for each group of 24. The design was as follows: letting A stand for one room condition and B for the other two basic conditions were treated, twelve subjects learning in A and recalling in A or (AA) and twelve subjects learning in A and recalling in B (AB). To control for possible differences in room effect on learning an equal number of subjects were given the original learning in each of the different rooms. For example, learning in B and recalling in B (BB) and learning in B and recalling in A (BA), thus four experimental and control groups were formed (AA), (BB), (AB), and (BA) with twelve subjects being in each group. The experiment was a three factor design with grade level, change vrs. no change, and room condition for recall making up the three factors. The subjects learned five of the eight syllables during OL.

Since the two rooms were completely crossed with the level and the amount of learning factor and since both the room factor and the amount of learning factor were completely crossed with the levels of the room environment factors the experiment was a complete factor design. This design allowed for comparison among the groups because all the data was separate and into distinct non-overlapping cells.

Procedure.--Each subject was tested individually. The subject was assigned an allotted schedule to appear at a certain room environment at a set time. The subject was then ushered into the room and read the instructions. The method of serial anticipation was used. The subject was asked to spell aloud the word that he thought would come next. This took place after he had watched the list rotate through completely once. Each syllable was presented for three seconds with a three second interval between each syllable. There was a twelve second interval between each list. Each subject was taken through the list until the alloted amount of learning was reached. This held true for all grades except for grade two. With this group the twelve second interval between the list was eliminated in order to save time. For the same group, because of a time factor, subjects that took over fifteen times to learn the five syllables required on learning were stopped. This was true for two subjects out of the 48 in the class.

In Room A the subject was set in front of the memory drum with the experimenter standing behind and recording the responses. In Room B the subject stood in front of the memory drum and the experimenter directly to his side recorded the responses. The *Ss* were instructed not to think about the words or review what had been done for the next 24 hours; and were reminded to return the next day at the same time. After the retention interval of 24 hours was completed the subject was taken to the appropriate room condition. All subjects were taken to 100% recall of all eight nonsense syllables. Also in recall session the twelve second interval between each list for the second grade was eliminated. The number of correct responses on learning and recall was recorded.

Results

Although each grade level was taken to the same level of learning during OL the younger subjects required more trials to learn than older; $F = 22.40$, ($df = 5,264$), $p < .001$. Consequently, to control for the number of practice trials during OL, an analysis of covariance was employed.

There was no difference between the change vrs. no change groups on the number of errors made on the first trial of relearning; F = 0.21, (df = 1,264), ρ> .05. However, the data presented in Table VII shows a significant contextual change effect for the trials to criteria during relearning measure (TC).

On the TC measure the group that changed context required more trials to relearn than the no change group across all age groups: $\bar{X} = 4.44$ vrs. $\bar{X} = 4.01$.

TABLE VII

SUMMARY OF ANALYSIS OF COVARIANCE FOR TRIALS (TC) TO CRITERION DURING RELEARNING

Source of Variation	Degrees of Freedom	Mean Square	F Ratio
A (Age)	5	3.35	1.01
B (Change vrs. No Change)	1	14.617	4.42*
A x B	5	2.83	0.85
C (Room for OL)	1	12.99	3.93*
A x C	5	1.24	0.37
B x C	1	1.15	0.34
A x B x C	5	3.29	

*ρ<.01

This difference between the change and no change group was in the predicted direction for each age group. Figure 1 presents the mean unadjusted TC scores for each age group and Figure 2 presents the adjusted scores used in the analysis of covariance. Figure 1 shows that while the change group required more trials to criterion, it is largest for the second grade. However, the same analysis of variance computed without including the second grade scores still produces a significant F for the change dimension: F = 6.99 (df = 1,220) ρ<.01. It, therefore, appears that the retention decrement resulting from a contextual change between OL and RL can be observed at the different age levels.

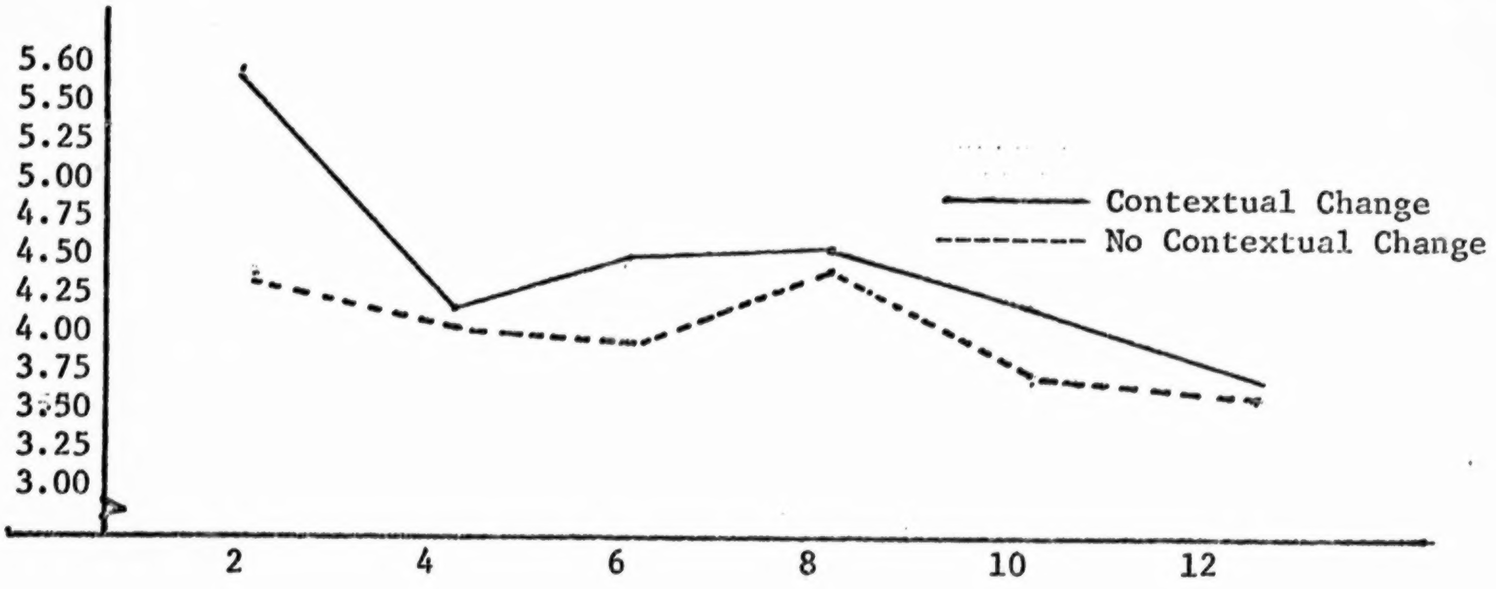

Fig. 1. Unadjusted means for trials to criterion for each age group.

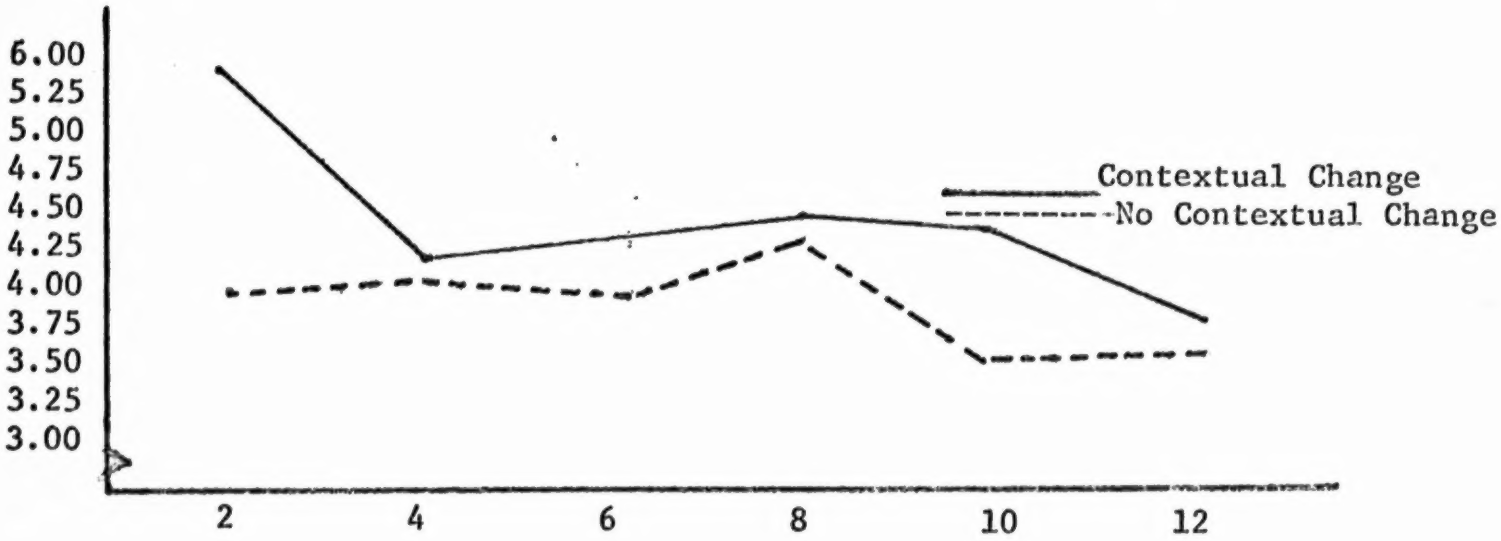

Fig. 2. Adjusted means for trials to criteria for each age and group change.

Experiment IV - Retention After a One-Half Hour Interval Using Connected Discourse

This experiment used the same apparatus, materials, presentation rate, number of subjects, design, and procedure used in Experiment I. However, only two rooms were used; Rooms A and Rooms B, and the retention interval was one-half hour.

The connected discourse used in this experiment was "so habitual become our expectation about symbols invariably possessing references that we tend unconsciously toward such assumptions concerning every word." During OL one-half of the Ss learned to a criterion of 20 correct anticipations, 100%. The other half were taken to a criterion of 50% during OL.

Results

Because Ss learning to a 60% criterion during OL performed unlike those learning to a criteria of 100%, in Experiment I a separate analysis was made for these two groups in this experiment. A comparison of MS error for recall and relearning show a significant differences in the variance of these two treatments. For example, the recall MS error for 60% criterion Ss is 127.85 while it is 8.38 for overlearners. All the subsequent analysis have revealed this same difference in performance and, therefore, over and underlearning Ss have been tested separately.

Table VIII and IX present the number correct on the first trial of relearning and the number of trials to criterion analysis for the underlearning Ss.

None of the main effects or interactions are significant. Tables X and XI present the same analysis of variance summaries for the Ss who learned to a criterion of 100%. It is, therefore, concluded that a change in context did not produce a retention decrement in this experiment using connected discourse.

TABLE VIII

ANALYSIS OF VARIANCE SUMMARY FOR NCFT SCORES FOR 60% OL Ss

Source of Variation	Degrees of Freedom	Mean Square	F Ratio
A (Change vrs. No Change)	1	1352.00	2.67
B (Room for OL)	1	722.00	1.43
A x B	1	666.12	1.31
Error	28	506.56	

TABLE IX

ANALYSIS OF VARIANCE SUMMARY FOR (TC) SCORES FOR 60% OL Ss

Source of Variation	Degrees of Freedom	Mean Square	F Ratio
A (Change vrs. No Change)	1	3.125	.346
B (Room for OL)	1	0.00	.000
A x B	1	8.00	.89
Error	28	9.067	

TABLE X

ANALYSIS OF VARIANCE FOR (NCFT) SCORES FOR 100% OL CRITERIA Ss

Source of Variation	Degrees of Freedom	Mean Square	F Ratio
A (Change vrs. No Change)	1	3.13	.37
B (Room for OL)	1	24.50	2.92
A x B	1	24.50	2.92
Error	28	8.38	

TABLE XI

ANALYSIS OF VARIANCE FOR (TC) SCORES FOR 100% OL CRITERIA Ss

Source of Variation	Degrees of Freedom	Mean Square	F Ratio
A (Change vrs. No Change)	1	9.03	2.06
B (Room for OL)	1	.28	0.06
A x B	1	5.28	1.20
Error	28	4.38	

Experiment V - Retention Classroom Material

Subjects.--The Ss were 62 volunteers from undergraduate psychology classes at Brigham Young University. The students were required to participate in research experiments to satisfy course requirements.

Apparatus and Materials.--A 20-min. lecture was developed and practiced with crucial and specific points clearly outlined. The lecture dealt with research procedures in Child Psychology. Each main point in the lecture had an accompanying visual chart which was simultaneously presented. The lecture was recorded on an audio tape. A sixteen item multiple choice test was prepared from the tape and visual aids to insure representative sampling of lecture material. One-half of the questions were prepared from visual displays used during the lecture, and the other half was based on auditory information.

Two classrooms were used. The first (A) was a well-designed and illuminated classroom with no alterations. The second room (B) was located in the basement of the library. This room was a windowless, small study area. In order to produce a large contrast the room was decorated with posters and with a red light for illumination; in the background a lively tempo jazz selection was played on a tape recorder. This radical decor in room B was used so that the rooms would be as qualitatively different from one another as possible.

Design and Procedure.--The Ss were randomly assigned into four groups when they entered the classroom. Two groups received the lecture in Room A and then one of these groups was tested in Room A, and the other in Room B. The second two groups received the introductory lecture in Room B and were tested in either A or B.

Because the students receiving the first lecture in the library were required to walk to the library before beginning the experiment, a 7-minute delay was required. Subjects arriving during this 7-minute delay were randomly assigned to either a change or no change group beginning in the classroom. Therefore, the groups receiving OL in the classroom had a larger n although the Ss were randomly assigned into the experimental and control group. The unequal cell n, although still proportional, was analyzed by an unweighted means analysis.

After receiving a lecture, all Ss were dismissed from the classroom in a supervised and orderly fashion. All vestiges of the lecture were removed from the classroom. According to a pre-assigned student number, each S was directed back to the appropriate classroom for the test of retention.

Results

A two-way analysis of variance test was employed. The first dimension consisted of whether the same or different rooms were used for OL and RL. The second dimension was the particular room used during the first session; either Room A or B. Table XII presents the two-way analysis.

TABLE XII

SUMMARY OF UNWEIGHTED-MEANS ANALYSIS OF VARIANCE FOR (NCFT) SCORES

Source of Variation	Degrees of Freedom	Mean Square	F Ratio
A (Change vrs. No Change)	1	.02	.06
B (Room for OL)	1	.14	.46
A x B	1	.52	1.67
Error	62	.31	

Inspection of the overall $\overline{X}$ of 11.28 suggests that the recognition test was of appropriate difficulty. The unusually small variance may have partly been responsible for the failure to find significance in this experiment. Because of the failure to find any effect in the analysis it is concluded that a retention wasy not altered by a contextual change as assessed in this experiment.

Experiment VI - Retroactive Inhibition-Connected Discourse to a Criterion of 100% During OL

Subjects.--Ss were 40 students, 20 males and 20 females, enrolled in a general psychology class during spring semester of 1969. They were freshmen who volunteered for research participation credit. None of the subjects had participated in a verbal learning experiment prior to this time.

Apparatus and Materials.--The same experimental room described in experiment I was used--Rooms A and B. Two lists taken from Slamecka's (1960) study were used. The first list stated "so habitual become our expectations about symbols invariably possessing reference, that we tend unconsciously toward such assumptions concerning every word." The second stated, "Communicators can exercise latitude in specifying meaning, however, they tend to choose, provided that such definitions correspond closely to customary usage."

Slamecka maintained that these lists can be successfully employed as interfering interpolated lists. In this experiment the first list was always the one that started "so habitual..." and the second was "communications..." Each word was presented serially in a memory drum. The subjects were asked to state the following nonsense syllable when a blank appeared in the window. The syllables were presented for three seconds with a three-second delay between each syllable and a 18-second intertrial interval.

Design.--The usual 3-stage RI design was used with original learning (OL) in interpolated learning (IL) and relearning (RL), but in addition, there was the additional manipulation of the contextual change letting A stand for the room used during OL, either the card room or the drum room, the room sequence would be AAA, AAB, ABB, ABA, A-A. Subjects were randomly assigned to one of these six groups. In each of the groups the subjects learned to a criterion of 100%. In addition, sex, room, time of day will counterbalance acrossed all conditions. The first four experimental groups had an interval of one minute between OL and IL and 20 minutes between OL and RL. A control group A-A had an interval of 30 minutes between OL and RL. The average amount of time required to learn the interpolated task required 10 minutes. All groups learned the interpolated tasks to a criterion of no errors following procedure.

The procedure was essentially the same for all groups. No preliminary practice was given. Ss were given instructions outside the room. Learned list scores were immediately recorded on a printed scoring sheet. The instructions read: "This is a learning experiment in which you will be asked to learn a list of words. It is very important that you follow the instructions carefully and would like to request that you do not discuss the experiment with other students who participate later. The words will appear one at a time in the window. Each word will appear for three seconds followed by a blank space for a period of three seconds. There will be 18 seconds at the end of the list in which nothing will appear in the window. Then an asterisk will reappear signalling the beginning of the second trial and the syllables will be presented in the same order as they were in the first trial. It is necessary that you pay strict attention to each word as it is presented. Your job will be to learn the list well enough so that you can say each word aloud just before it comes to the window. When you see the first syllable try to anticipate the second one. When you see the second try to anticipate the third and so on through the list. Don't try to anticipate the asterisk but wait for it to appear in the window and then try to anticipate the first syllable. Always try to get as many syllables as possible in every trial regardless of whether you have anticipated all of them or only a few of them on previous trials. Don't worry if you can't remember as many on one trial as you have on previous trials, but do try to get as many as you can each time through the list. If you think you know what a word will be but you are not sure, guess. It is all right to guess since guessing will not count against you." During the 20-minute interval all subjects were taken into a hallway outside the experimental room and asked to read a story in a popular magazine.

Results

The first dependent variable was the trials required to learn to a criterion of 100% correct. The second was the number of errors on the first trial of relearning (NEFT). The first dimension in a two-way fixed analysis of variance was change versus no change of context between sessions one and three, the second was change versus no change in context between sessions 2 and 3. A preliminary comparison was run between group AA and four experimental groups and the two control groups to determine if RI had occurred.

In order to first test for RI effects the group AAA was compared with A-A on both the recall and relearning measures. Table XIII presents the data for these comparisons.

The data presented in Table XIII shows that the procedure did not produce RI and accordingly the contextual change employed to reduce RI in the remaining experimental groups would be fruitless. Therefore, no further data analysis in this experiment was considered.

TABLE XIII

MEANS AND t RATIOS FOR EXPERIMENTAL VRS. CONTROL COMPARISONS FOR (NEFT) AND (TC)

Variable	Experimental $\overline{X}$(AAA) n=8	Control (A-A)$\overline{X}$	t
Recall MS error = 12.18	6.62	5.62	.57
Trials MS error = 3.18	4.12	4.12	0

Experiment VII - Retroactive Inhibition-Connected Discourse--Under-Learning to a Criterion of 60% During OL

Procedure.--The Ss, apparatus, design, procedure in this experiment was the same as that in Experiment VI. The only change was the amount of learning during OL. In this experiment subjects were taken to a criterion of 50% errors on OL rather than no errors.

Results

In order to first test for RI effects, this typical RI group (AAA) was compared with usual control group (AA) on both the recall and relearning measures. Table XIV presents the data for these comparisons.

TABLE XIV

MEANS AND t RATIOS FOR EXPERIMENTAL (AAA) VRS. CONTROL (A-A) COMPARISONS FOR NEFT (RECALL) AND RELEARNING (TC)

Variable	Experimental $\overline{X}$ n=8	Control $\overline{X}$ n=8	t
Recall MS error = 5.04	17.12	11.37	5.13 *
Trials MS error = 7.75	8.75	9.00	.18

* p< .001

Table XIV shows a strong RI effect for the NEFT measure but no RI effect for TC scores. Accordingly, the analysis of variance for TC will not be considered when making the following analysis.

The four experimental groups AAA, ABA, ABB, AAB, were analyzed by a fixed effects ANOVAR model. Factor A was a change verses no change between OL and IL. Factor B was a change vrs. no change between session OL and RL. Table XV presents the analysis.

Finding a significant interaction a Duncans Multiple Range Test was run. Table XVI presents the Duncans analysis and the cell means.

TABLE XV

SUMMARY OF ANALYSIS OF VARIANCE FOR UNDERLEARNING Ss ON (NEFT) SCORES

Source of Variance	Degrees of Freedom	Mean Square	F Ratio
A (Change vrs. No Change OL-IL)	1	9.03	1.79
B (Change vrs. No Change OL-RL)	1	.78	.58
A x B	1	22.78	5.87 *
Error	28	5.04	

* $p < .05$

TABLE XVI

CELL $\overline{X}$s AND DUNCANS MULTIPLE COMPARISONS FOR 60% CRITERION Ss (NEFT) SCORES

	$\overline{X}_2$	$\overline{X}_3$	$\overline{X}_1$	$\overline{X}_4$
$\overline{X}_2$ (ABA) = 14.37	--	.78	1.38	2.75
$\overline{X}_3$ (AAB) = 15.12		--	.63	2.00
$\overline{X}_1$ (ABB) = 15.75			--	1.37
$\overline{X}_4$ (AAA) = 17.12				--

Differences significant at $p < .05$ underlined

The Duncans analysis finds that the difference exists between the usual AAA RI group and the group which had the interpolated learning in a changed context. As predicted, the ABA group made fewer errors. The failure of groups ABB to AAB also to be significant corresponds to the earlier findings in the connected discourse retention experiment that a change between OL and RL does not have a strong effect. Perhaps remaining in the context were the interfering IL list was presented counteracted the advantage gained by the IL contextual change.

Experiment VIII - Retroactive Inhibition Connected Discourse

Subjects.--The Ss for this experiment were 60 male undergraduate students enrolled in general psychology at the University of Notre Dame. The majority of Ss were naive with respect to the present kind of experiment.

Apparatus.--Learning took place for some Ss in two different environments. Environment 1 (Room 1) was 14 ft. x 8 ft. x 10 ft. in dimension, painted light green with a light-colored linoleum tile flooring, and contained several screened ceiling lights. This room was furnished with a single table on which a Lafayette Memory Drum was placed, and around which were located two folding chairs. Environment 2 (Room 2) was a small closet under a flight of stairs whose dimensions were approximately 5 ft. x 12 ft. and whose floor and ceiling slanted in such a manner as to give the room a triangular appearance. The floor slanted with a 5-10^{o} slope and the ceiling slanted such that, at the entrance of the room, it was 8ft. from floor to the ceiling and, at the terminus of the room, it was 1 1/2 ft. from the floor to the ceiling. Room 2 was furnished with shelves which extended the full left hand wall and which were cluttered with various articles including coffee cans, light bulbs, books, colored boxes, etc. A large fan was located beneath the shelves and turned on during the experiment both to cool the room and to provide a masking noise. At the back of the room were open storage boxes and at the right of the room the wall was decorated with pictures and posters of different colors and sizes. A small table, which contained a Wollensach tape recorder, and 2 folding chairs against the unshelved right wall were the only furniture in the room. The table was arranged so that Ss was always facing downhill toward E.

There were two Es, a male in Room 1 and a female in Room 2.

The materials to be learned consisted of sentences which were presented to the Ss by means of the Lafayette memory drum in room 1 or the Wollensach tape recorder in Room 2. During original learning and relearning, the Ss learned the following sentences:

(1) I felt he had much knowledge of that deep classical spirit.

(2) His power was a deep spiritual genius which has since declined in magnitude.

(3) I was scarcely acknowledged much less given the feeling of a genius.

During the interpolated learning task the Ss learned the following sentences:

(1) He scarcely opened his lips much less offered opinion the whole way.

(2) His genius was not a spirit which descended to him through air.

(3) I felt the deeper power and pathos which had been since acknowledged.

(4) I think he had much feeling for the classical and the elegant.

Procedure.--The *Ss* randomly were assigned into three groups of 20 each. During original learning. three groups learned the three sentences to a criterion of 60% (i.e., 22 of the 36 words were anticipated correctly). During the IL test, 2 of the groups learned the above four sentences to a criterion of 100% while the third group was not required to learn the sentences. Instead, the latter were occupied with light reading. During relearning, all *Ss* relearned the three original sentences to a criterion of 100%.

All conditions were counterbalanced, where possible. For example, half of the *Ss* in the experimental change group learned their materials in a reversed sequence of rooms (i.e., one half of the *Ss* received original and relearning in Room 1 and interpolated learning in Room 2 while the other half had interpolated learning in Room 1.)

The sentences were presented in a serial fashion at a 2-second presentation rate on both the memory drum and the tape recorder and a 4-second intertrial interval was used. Twenty min. intervened between IL and RL and all *Ss* were required to walk an equivalent distance before IL commenced.

Results

Both errors and trials to 60% criterion were analyzed in the present study. The number of correct responses on the first trial of RL was not scored. To insure that the two experimental and one control groups were equivalent for original learning, the groups were compared on these two measures. There was not a statistically significant difference. Also, it should be noted that the two experimental groups performed equivalently on the interpolated learning task ($F<1$).

A comparison of the errors to 60% learning on the relearning task for the 3 groups produced a reliable *F*-value ($F = 3.79$, $df = 2/57$, $p<.05$). Table XVII represents the number of errors made by each of the three groups for OL and RL.

As seen, the experimental group whose room during IL was different ~~than during original relearning~~ performed almost identically to controls and both made reliably fewer errors than the experimental group who received all three learning experiences in the same environment. A similar finding occurred with regard to the number of trials taken to each 60% during relearning.

This experiment indicated that when IL was conducted in an environment substantially different from that where original and relearning occurred, relearning was better than when all three tasks occured in the same setting.

TABLE XVII

MEAN NUMBER OF ERRORS TO CRITERION DURING OL AND RL

Group	OL $\overline{X}$	RL $\overline{X}$
Experimental Change	74.6	23.1
Experimental No Change	94.25	40.1
Control	80.0	21.2

Experiment IX - Retroactive Inhibition Classroom Materials

Subjects.--The Ss of this experiment were 72 female students, 18-21 years of age, taken from introductory psychology classes at St. Mary's College, Notre Dame, Indiana. Sixteen of these Ss had taken the introductory psychology course the previous semester and the remainder presently were taking the course.

Apparatus.--One lecturer, dressed in a religious habit consisting of a black cassock and Roman collar and cord, presented all of the lectures except one, and administered one-half of the tests. Another student was casually dressed in a paint-spotted sweatshirt and levis, and presented one lecture and tested one-half of the Ss. The lecture was a 15 min. oral presentation of an analysis of Carl Rogers' self theory and client-centered therapy.

Twenty multiple-choice questions were used for testing (questions available on request). Ten of these were designed to test actual material from the lecture, and were labeled as concrete-type questions. An example of a concrete question was: Carl Rogers received his Masters degree from (a) the University of Wisconsin, (b) Ohio State University, (c) Columbia University, (d) the University of Chicago. The other 10 questions pertained to abstractions or inferences that could be made from the lecture materials and, hence, were labeled as abstract-type questions. An example was: Rogers is similar to Freud in that (a) he has two systems which may conflict in the personality, (b) he uses the terms conscious and unconscious in the same way, (c) he has a similar type of therapy, (d) he considers that most people need therapy.

A pilot study was conducted to validate both the test procedure. The pilot study involved 16 student seminarians residing at Moreau Hall, Notre Dame, Indiana. The study consisted of the 15-min. lecture on Carl Rogers' theory and a test consisting of 30 multiple-choice questions on the lecture material. It was from these multiple-choice questions that the 20 used above were chosen. Selections of questions were based upon percentages of correct responses in the pilot study. In the case of the concrete questions, questions which were answered correctly from 37-75% of the time (mean 58.2%) were used. The abstract questions selected were correctly answered from 19-81% of the time with the mean being 48.8%. This difference in mean percentages between the abstract and concrete questions was not reliable ($t<1$).

Two environments were employed. One setting (Room 1) measuring 8 x 20 ft. was evenly lighted by six 300-watt, silver-frosted bulbs. Care was taken to provide normal classroom background noise, and the room contained 36 desks neatly arranged in 3 rows of 12 each, with at least 18 in. between each desk. This room also had one large teacher's desk, chair, and a lecture podium. This setting was kept clean, with furniture being arranged in an orderly fashion with an ordinary classroom blackboard and with windows open during all facets of the experiment.

The other environment (Room 2) was a 30 x 30 Ft. space fashioned from a larger room measuring 30 ft. x 50 ft. which ordinarily was used for art classes. This room also was lighted with six 300-watt lamps from that part of the room that was not used for class (lighting thus came only from a direction facing S). Room 2 had background noise consisting of a radio station (WSBT-AM at low volume). The front of the room was composed of a "hippie" poster, a 3 ft. x 6 ft. blackboard with a hole in the lower left corner, a 7 ft. x 2 ft. modern glass ornament, a 6 ft. high modern sculpture of a woman, and 2 metal stools approximately 10 ft. apart which supported several paintings. All windows were closed and the room purposely was kept cluttered, unkempt, uncomfortably furnished, and with 16 scattered desks. The floor was concrete.

Eighty sets of 3-page answer sheets were used and distributed to the Ss.

Procedure.--All Ss were first presented the lecture, given an interpolated task, and then, after a period in which they all worked an equivalent distance, were tested. Four groups were involved. One was lectured to in Room 1 and tested in Room 1, group 2 was lectured to in Room 1 and tested in Room 2, group 3 received the lecture in Room 2 and was tested in Room 1, and group 4 was both lectured and tested in Room 2.

A non-related task was employed to occupy S for an approximate 20-min. period following the lecture. For the first 10 min. following the lecture each S was instructed to peruse two magazines and was asked to pick out her favorite advertisement using such criteria as color, product, and advertising technique and/or artistic value. For the remaining 10 min. of the interpolated period, each S was engaged in a relaxed conversation with E. All Ss then were moved either to a room different from that in which they were lectured or simply moved a comparable distance and returned to the original room from which they initially were seated. This took approximately 80 sec.

One additional feature of this study should be noted. An attempt was made to assess whether the contextual variable was more effective when lecturing and testing was done in groups or done individually. Hence, 32 Ss were tested and lectured to in groups (8 Ss per group) and 40 Ss were given the lecture individually and tested individually (10 Ss per group). All groups were formed by equating Ss on cumulative grade point average. That is, all Ss were ranked from the highest to the lowest GPA. The resulting distribution was thus subdivided into 9 levels of 8 Ss each. Ss were randomly assigned to one of the appropriate experimental or control groups on a random basis.

Results

To review, the present study consisted of two parts; namely, that dealing with the effect of contextual change on retention of classroom materials when the materials are acquired in a group setting or when materials are acquired individually.

Equating Procedure.--All groups were equivalent with regard to the grade-point-average criterion variable. That is, when considered separately, the 4 groups who were lectured to individually did not differ on this variable ($F<1$), nor did the four groups who were lectured to collectively ($F<1$).

Test data.--The test data were collected in terms of the number correct received for both abstract and concrete questions. Two, 2-way factorial analyses of variance were performed on the data. The first pertained to the performance of the 4 groups who were lectured to and tested collectively. Change vs. no change and abstract vs. concrete constituted the two dimensions of this analysis. The only reliable difference that emerged from this analysis was that between the abstract and concrete questions, the latter being somewhat more difficult than the former. The F for the contextual change dimension was <1, as was the interaction.

Identical conclusions emerged from the similar analysis which was applied to the data gathered when lecturing and testing was performed individually. Unfortunately, it was not possible to demonstrate in the present study that contextual changes can influence the retention of material which is presented in the manner typical to that encountered in everyday classrooms.

Experiment X - Retroactive Inhibition Classroom Materials

Subjects.--The Ss were 80 male undergraduate students enrolled in beginning psychology courses at Brigham Young University. These subjects volunteered to participate in research to satisfy course requirements.

Materials and Room Environments.--Two mimeographed paragraphs used by Luchins (1942) to create attitudes about a ficticious person names Jim were utilized. One extroverted message (EM) portrayed rather friendly and outgoing behavior, while the other paragraph (IM) described withdrawn or introverted behavior. Both messages described Jim's reactions to similar situations.

A questionnaire used by Luchins (1942), asking Ss to predict Jim's behavior under different situations, measured the impact of the two paragraphs in creating attitudes about Jim. Subjects were also required to write the first paragraph from memory, to the best of their ability. This will allow the investigators to test contextual effects upon attitude recall.

Two experimental conditions, the classroom and the cafeteria, were used in the experiment. The classroom was a medium sized classroom used for psychology classes and seated approximately 30 people. The experimenter presented the experiment in a formal and rigid manner. He was dressed in a suit and tie, and the Ss were treated as if they were in a classroom situation. The student center snack bar comprised the second environmental context. It was used because of the physical and psychological contrasts it provides. Students use the snack bar to relax and enjoy themselves in an informal atmosphere. The experimenter followed the same procedure in this second context except that the session was more relaxed. He was dressed in slacks and a sport shirt. The experiment was conducted during business hours in one section of the snack bar.

Design.--A design similar to the three stage retroactive design, used during learning experiments, was utilized: OL, IL, and RL.

Letting A stand for the room used during OL, either the classroom or the cafeteria, and B standing for the other, the room sequence was one of the following: AAA, ABA, A-A, A-B. The last two groups were control groups, and they did not receive the second paragraph. All groups were counterbalanced with respect to room order. This necessitated having 16 groups with 15 subjects in each group.

Procedure.--It took approximately 40 minutes for each group to complete the three main sections of the experiment. The first section consisted of giving instructions and presenting the first paragraph. Subjects had two minutes to read and study the paragraph. The material was then collected and the Ss were taken to the next context in which their group was participating. It took five minutes to get from one context to the other, and involved walking outside. To standardize the

the procedure, groups who remained in the same context still went outside for the allotted time. This procedure was explained to the Ss as being necessary to standardize the experimental process. No S had any knowledge of the procedure or sequence of the other groups and the real purpose of the experiment was not known.

The second section consisted of presenting the second message about Jim. Again each S had two minutes to look at the paragraph, and then it was collected. Subjects were then taken to the next context by use of the intermediate procedure mentioned previously. After reaching the destination, instructions were given and the questionnaire was administered.

Each S was read the following set of instructions upon entering Room A for the initial phase of the experiment.

> In everyday life we sometimes form impressions of people based on what we read or hear about them. You will be given a paragraph about a person named Jim. Please read and study this paragraph but do not discuss any of this experiment or the materials in it until it is over.

The following instructions will be read to the Ss during the second session.

> The paragraph which you will no receive contains additional information about Jim. Please read it during the next two minutes.

The two control groups, which did not receive the second message, were taken to a lounge area, and given a story problem in deductive logic. This interpolated task was not related to the experimental task, but nevertheless, was both interesting and enjoyable. Each S was told to try to solve the problem and to state the logic for his answer. At the end of the allotted time, the same as for the experimental groups, the Ss were taken to the next context. A mimeographed sheet giving the correct answer and logic was distributed at the end of the experiment.

The post test questionnaire was distributed in three parts with the following instructions.

> Please fill out this questionnaire to the best of your ability, and give the most correct answer. Some of the questions ask you to give what you feel would be Jim's reaction to a hypothetical situation. Please do not discuss any of the questions until after the experiment is over. Answer each question separately and in numerical order.

The material was collected and the Ss were then dismissed.

Five scores were developed from the materials described above. The first score was attitude change from the 15 item scale developed by Luchins. The scoring procedure recommended by Luchins was followed: A extroverted response received a score of three, a neutral received two, and an introverted response received one. Note that the extroverted measure was presented during OL. This measure will be referred to as attitude chang (Att. Chg.). Next the written paragraph was analyzed for recall of each basic event described in the extroverted message. Again a three-point scale was used with an extroverted event receiving three points, a neutral two points, and an introvert response one point. This measure will be called cognitive retention (CR). Agreement between two raters working independently was used in assigning the points to the two measures described above.

Next a list of words which appeared in only one of the messages and not in the other message was prepared. Each S's paragraph was then read and plotted against the previously prepared list of words. Using this procedure it was possible to identify the number of words from extroverted message that the subject wrote in his paragraph and also the number of words from the introverted message. These measures will be called verbatim recall and will be designated as (VE) and(VI)for the extroverted and introverted messages. Both the number of introverted and extroverted words were recorded separately and a fifth measure was a difference between the extroverted minus the introverted words (VE-VI).

Results

Tables XVIII through XXVII present analysis of variance summaries and comparisons of means with Duncan's Multiple Range Statistics. The two factor analysis of variance used the four groups, AAA, ABA, A-A, and A-B, as factor A and the room used during OL as factor B. Each ANOVAR table contained at least one significant F ratio and so each analysis is followed by a Duncan's comparison of the means.

An inspection of these tables shows that the unaltered RI group AAA performed poorer on the retention measures than the usual control group A-A on all of the measures.

It is, therefore, concluded that the procedures employed clearly produced RI. The next question of concern was whether a change in context between OL and RL for the two control groups AA vrs. AB was significant. The Duncan's test finds no difference between these means on any of the measures. Since the two means are almost the same value on each measure, it is not reasonable to believe that a more powerful statistic would find significance between these groups.

The primary question for this experiment is answered by comparing group AAA with ABA to see if RI can be reduced by placing the interpolated learning in a different context. This comparison was significant on the cognitive retention measure and the VE-VI measure for Ss receiving OL in a classroom. Figure 2 and 3 present the interaction analysis. Note that the ABA group is intermediate in location between the RI and two control groups. It indicates that learning the interpolated list in the cafeteria reduces its interferring effect when OL and RL are in a classroom. An objection to this conclusion may be raised, however. It could be asserted that because the reverse room sequence was not significant, using the cafeteria for OL, the difference may be due to poorer learning if the interpolated message rather than a change in context. In order to test this assertion a comparison between the groups A-A using the cafeteria for OL and A-A using the classroom was made for these measures. Factor B gives the overall test and it is not significant on any of the measures. In addition, the means are almost identical; 12.19 vrs. 13.19 for VE-VI. Thus it seems unreasonable to believe that one room caused a lower level of OL learning and, therefore, it is believed that the retention decrement was due to the change in context.

TABLE XVIII

ANALYSIS OF VARIANCE FOR COGNITIVE RETENTION

Source of Variation	Degrees of Freedom	Mean Square	F Ratio
A (Groups)	3	23.68	24.35**
B (Room OL)	1	1.25	1.28
AB	3	5.21	5.36*
Error	72		

$^{*}\rho < .01$
$^{**}\rho < .001$

TABLE XIX

DUNCAN'S MULTIPLE RANGE STATISTIC FOR COGNITIVE RETENTION

Group MS = .97 n = 10	$\bar{X}_1$	$\bar{X}_4$	$\bar{X}_2$	$\bar{X}_3$	$\bar{X}_5$	$\bar{X}_7$	$\bar{X}_6$	$\bar{X}_8$
$\bar{X}_1$ = 5.80 AAA Cl	----	$\underline{1.40}$	$\underline{1.50}$	$\underline{\underline{2.40}}$	$\underline{\underline{2.90}}$	$\underline{\underline{2.90}}$	$\underline{\underline{3.10}}$	$\underline{\underline{3.20}}$
$\bar{X}_4$ = 7,20 ABA Caf		----	.10	$\underline{1.00}$	$\underline{\underline{1.50}}$	$\underline{\underline{1.50}}$	$\underline{\underline{1.70}}$	$\underline{\underline{1.80}}$
$\bar{X}_2$ = 7.30 AAA Caf			----	$\underline{.90}$	$\underline{\underline{1.40}}$	$\underline{\underline{1.40}}$	$\underline{\underline{1.60}}$	$\underline{\underline{1.70}}$
$\bar{X}_3$ = 8.20 ABA Cl				----	.50	.50	.70	.80
$\bar{X}_5$ = 8.70 A-A Cl					----	0.0	.20	.30
$\bar{X}_7$ = 8.70 A-B Cl						----	.20	.30
$\bar{X}_6$ = 8.90 A-A Caf							----	.10
$\bar{X}_8$ = 9.00 A-B Caf								----

Single underline = $\rho < .05$
Double underline = $\rho < .01$

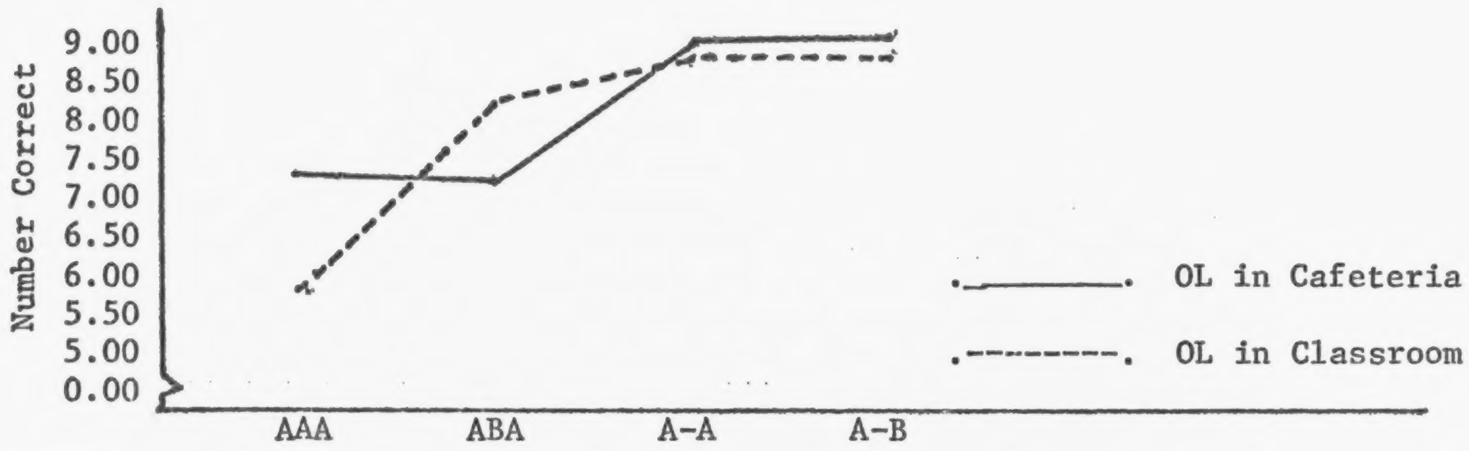

Fig. 3. Cognitive Retention Scores for experiment and control group.

TABLE XX

ANALYSIS OF VARIANCE FOR VE-VI SCORES

Source of Variation	Degrees of Freedom	Mean Square	F Ratio
A (Groups)	3	102.35	11.67***
B (Room OL)	1	27.61	3.15*
AB	3	33.98	3.87**
Error	72	8.76	0.00

*$\rho < .05$
**$\rho < .025$
***$\rho < .01$

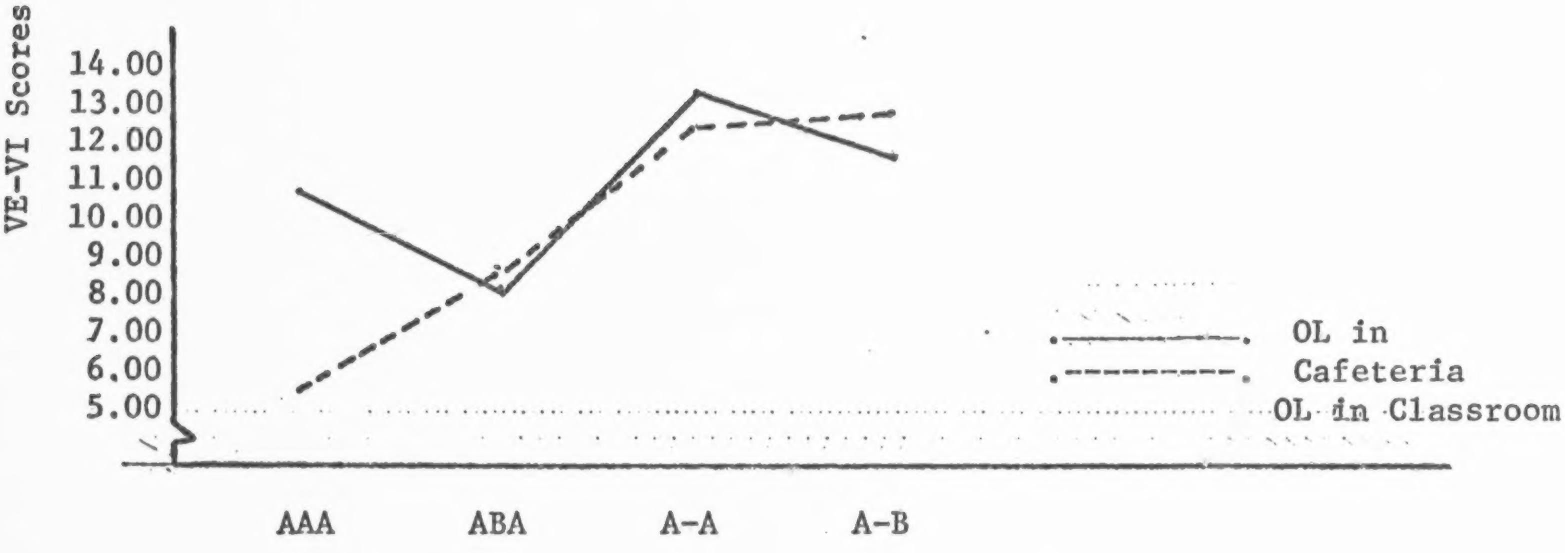

Fig. 4. VE-VI scores for experiment and control groups.

TABLE XXI

DUNCAN'S MULTIPLE RANGE STATISTIC FOR VE-VI SCORES

Group MS = 8.76 n = 10	$\bar{X}_1$	$\bar{X}_4$	$\bar{X}_3$	$\bar{X}_2$	$\bar{X}_8$	$\bar{X}_5$	$\bar{X}_7$	$\bar{X}_6$
$\bar{X}_1$ = 5.80 AAA Cl	----	$\underline{2.80}$	$\underline{3.10}$	$\underline{\underline{4.90}}$	$\underline{\underline{5.80}}$	$\underline{\underline{6.40}}$	$\underline{\underline{6.70}}$	$\underline{\underline{7.40}}$
$\bar{X}_4$ = 8.60 ABA Caf		----	.30	2.10	$\underline{\underline{3.00}}$	$\underline{\underline{3.60}}$	$\underline{\underline{3.90}}$	$\underline{\underline{4.60}}$
$\bar{X}_3$ = 8.90 ABA Cl			----	1.80	$\underline{2.70}$	$\underline{3.30}$	$\underline{3.60}$	$\underline{\underline{4.30}}$
$\bar{X}_2$ = 10.70 AAA Caf				----	.90	1.50	1.80	2.50
$\bar{X}_8$ = 11.60 A-B Caf					----	.60	.90	1.60
$\bar{X}_5$ = 12.20 A-A Cl						----	.30	1.00
$\bar{X}_7$ = 12.50 A-B Cl							----	.70
$\bar{X}_6$ = 13.20 AA Caf								----

Single underline = $\rho < .05$
Double underline = $\rho < .01$

TABLE XXII

ANALYSIS OF VARIANCE SUMMARY FOR ATTITUDE CHANGE

Source of Variation	Degrees of Freedom	Mean Square	F Ratio
A (Groups)	3	317.23	9.90*
B (Room OL)	1	8.44	.26
AB	3	68.48	2.14
Error	72	32.04	

*$\rho < .01$

TABLE XXIII

DUNCAN'S MULTIPLE RANGE STATISTIC FOR ATTITUDE CHANGE

Group MS = 32.04 n = 10	$\bar{X}_1$	$\bar{X}_2$	$\bar{X}_3$	$\bar{X}_4$
$\bar{X}_1 = 29.75$ AAA	----	2.44	7.44	8.30
$\bar{X}_2 = 32.19$ ABA		----	5.00	5.86
$\bar{X}_3 = 37.19$ A-A			-----	.86
$\bar{X}_4 = 38.05$ A-B				----

Single underline = $\rho <.05$
Double underline = $\rho <.01$

TABLE XXIV

ANALYSIS OF VARIANCE SUMMARY FOR VE SCORES

Source of Variation	Degrees of Freedom	Mean Square	F Ratio
A (Groups)	3	43.04	4.64 *
B (Room OL)	1	6.61	0.73
AB	1	11.44	1.26
Error	72	9.05	

*$\rho < .01$

TABLE XXV

DUNCAN'S MULTIPLE RANGE STATISTIC FOR VE SCORES

Group MS = 9.05 n = 10	$\bar{X}_1$	$\bar{X}_2$	$\bar{X}_4$	$\bar{X}_3$
$\bar{X}_1 = 10.85$ AAA	----	.40	$\underline{2.45}$	$\underline{\underline{2.90}}$
$\bar{X}_2 = 11.25$ ABA		----	$\underline{2.05}$	$\underline{2.50}$
$\bar{X}_4 = 13.30$ A-A			----	.45
$\bar{X}_3 = 13.75$				----

Single underline = $\rho < .05$
Double underline = $\rho < .01$

TABLE XXVI

ANALYSIS OF VARIANCE SUMMARY FOR VI SCORES

Source of Variation	Degrees of Freedom	Mean Square	F Ratio
A (Groups)	3	17.15	5.60*
B (Room OL)	1	1.51	.49
AB	3	3.38	1.10
Error	72	3.05	

*$\rho < .01$

TABLE XXVII

DUNCAN'S MULTIPLE RANGE STATISTIC FOR VI SCORES

Group MS = 3.06 n = 10	$\bar{X}_3$	$\bar{X}_4$	$\bar{X}_2$	$\bar{X}_1$
$\bar{X}_3 = 1.35$ A-A	----	.15	$\underline{1.45}$	$\underline{\underline{1.85}}$
$\bar{X}_4 = 1.50$ A-B		----	$\underline{1.30}$	$\underline{\underline{1.70}}$
$\bar{X}_2 = 2.80$ ABA			----	.40
$\bar{X}_1 = 3.20$ AAA				----

Single underline = $\rho < .05$
Double underline = $\rho < .01$

Experiment XI - Proactive Inhibition - Nonsense Syllables - To Criterion of 60% OL

Method

Subjects were 48 students; 24 males and 24 females enrolled in general psychology classes. They were predominately freshmen who volunteered for research participation credit. None of the Ss had had any experience with verbal learning experiments. The apparatus, memory drum instructions, rooms, and procedure were the same as that used in Experiments II, Vi, and VII RI connected discourse. Material, however, consisted of two lists of nonsense syllables. The first list of syllables were QEF, MOY, JIF, GEH, XIN, NEF, QAH, ZUF, SIZ, WOH. The list two consisted of WUZ, RAJ, EXP, JIR, QUZ, BEH, XAK, YIX, JAT, CIT. These syllables were adopted from those used by Greespooon and Ranyard. In this experiment the usual three session PI, OL, RL design was employed. The control group did not have the first session. In this case the contextual change again occurred between the PL and OL and between OL and RL, and also between OL and RL for the control groups. Accordingly, there were then ten groups letting A stand for either the card room or the drum room. The sequence of rooms would be as follows: AAA, ABA, AAB, ABB, -AA-.

Results

Before considering the effects of contextual change on PI, it is necessary to determine if the procedure had produced by comparing the unaltered RI group AAA with the control group. Although all the Ss learned to a criterion of 60% correct anticipation during OL, the control Ss required more trials to reach this criterion, $\bar{X}$=9.12 as opposed to $\bar{X}$=5.12 for the AAA group. This difference is attributed to the PL session providing the AAA group learning to learn opportunities/ To control for this difference ajusted means were computed using trials to criterion during OL as the covariate. Table XXVIII presents this comparison for trials to criterion (TC) during RL and the same comparison for the number incurred correct anticipation (NEFT) on the first trial of relearning.

TABLE XXVIII

ADJUSTED MEAN AND t RATIOS FOR RI (AAA) VRS. CONTROL GROUP (AA) ON (TC) AND (NEFTR)

Variable	Experimental $\bar{X}_{AAA}$ n=8	Control $\bar{X}_{AA}$ n=8	t
TC MS = 21.12	11.16	4.46	2.43 **
(NEFTR) MS = 1.43	5.30	3.95	1.87 *

* p<.05 ** p<.005

The difference presented in Table XXVIII is significant so it is concluded that the procedure produced RI. Next a two way factorial design is used to compare the contextual change groups, AAA, ABA, ABB, AAB. The first factor, A, denotes whether there was a change between PL and OL and refers to a change between OL and RL. An analysis of covariance was used to control for the number of trials during OL. The groups which changed between RL and OL required a $\overline{X}$=36.94 trials to reach the 60% criterion during OL while those not changing required an average of 26.87. This difference was not significant, F=1.48, 1,28. But the fact that the group received almost a fourth more practice trials to reach the criterion is still a considerable difference and to control for this difference, an analysis of covariance was run. Table XXIX and XXX presents the analysis of covariance for the two measures.

TABLE XXIX

ANALYSIS OF COVARIANCE SUMMARY TABLE FOR TC

Source of Variation	Degrees of Freedom	Mean Square	F Ratio
A (Change PL-OL)	1	18.54	5.17 *
B (Change OL-RL)	1	62.85	1.72
A x B	1	23.84	.65
Error	27	36.41	

* p < .05

TABLE XXX

ANALYSIS OF COVARIANCE SUMMARY TABLE FOR NEFT

Source of Variation	Degrees of Freedom	Mean Square	F Ratio
A (Change PL-OL)	1	11.83	4.50 *
B (Change OL-RL)	1	1.27	.48
A x B	1	3.45	1.31
Error	27	2.62	

* p < .05

Tables XXIX and XXX show that the groups changing between PL and OL, ABA and ABB, show less forgetting than the RI groups which did not change, AAA and AAB, between PL and OL.

The PL-OL change group required 8.22 trials to reach criterion as compared to a $\bar{X}$=13.15 for the no PL-OL change. They also made fewer errors $\bar{X}$=4.51 as compared to $\bar{X}$=5.74 for the no PL-OL change group. In order to illustrate the amount of forgetting of the PL-OL change group relative to the usual RI (AAA), and control group Figures 4 and 5 are presented. Note that the PL-OL change group is almost intermediate between the other groups.

It is, therefore, concluded that for the low level of PL learning used in this experiment, the procedure of changing the ambient contextual surrounding between PL and OL reduces the amount of proactive interference.

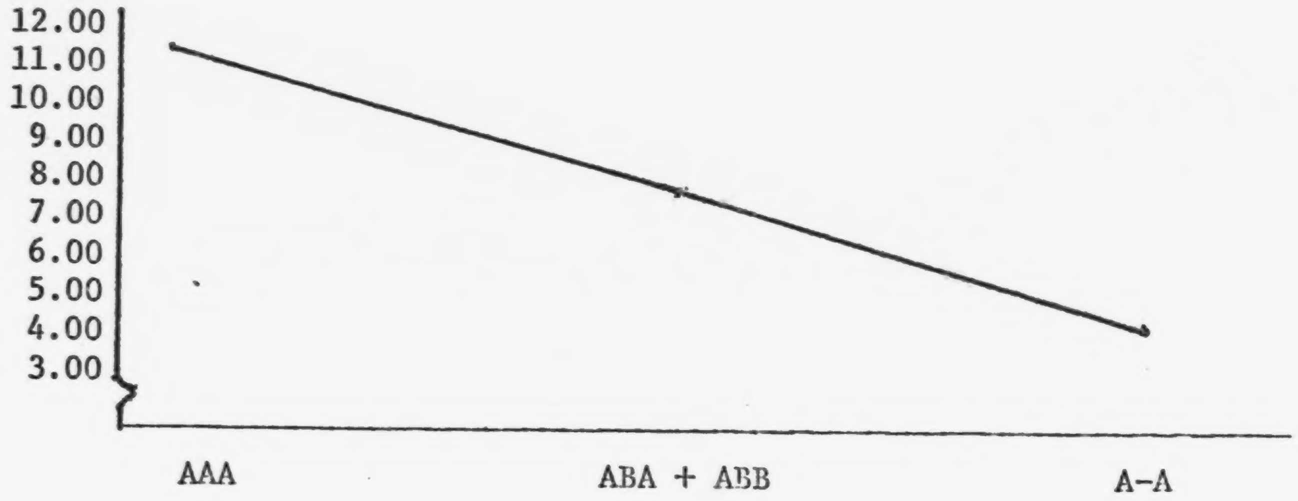

Fig. 5. Adjusted mean number of trials to criterion for groups AAA, ABA + ABB, and A-A

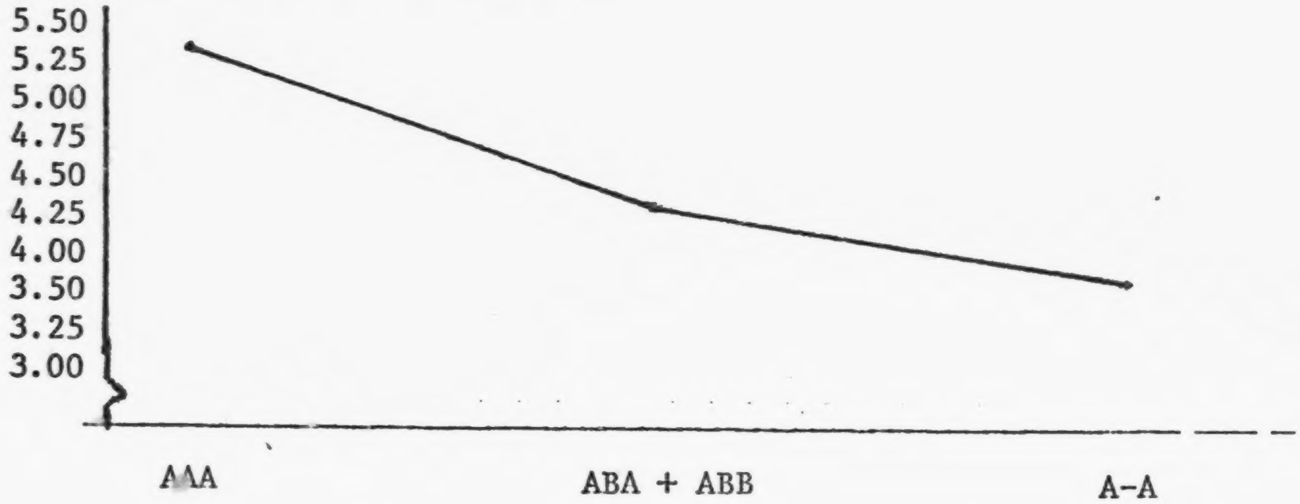

Fig. 6. Adjusted mean number of errors on first trial of relearning for groups AAA, ABA + ABB, and A-A

Experiment XII - Proactive Inhibition-Nonsense Syllables-to 100% OL

This experiment used the same source and number of Ss, procedure and design as Experiment IX. The single exception was the learning criterion of 100% correct anticipations for OL learning instead of 60%.

Results

Following the same procedure used in Experiment IX the first comparison was between the AAA and -AA groups to see if Pi was produced. This data is presented in Table XXXI.

TABLE XXXI

COMPARISON BETWEEN THE RI (AAA) AND CONTROL GROUPS (-AA)
ON (TC) AND (NEFT)

Source of Variable	AAA $\overline{X}$	-AA $\overline{X}$	t
Trials MS error = 2.19	.87	1.11	.002
Recall MS error = 1.37	1.26	1.08	.41

The results presented indicated that PI had not been produced and, therefore, no further analysis investigating contextual change would be meaningful.

Experiment XIII - Proactive Inhibition-Connected Discourse

Subjects.--Ss were 63 male and 63 female students enrolled in general psychology courses at Brigham Young University. They were predominately freshmen volunteers who had not had previously participation in verbal learning.

Apparatus and Materials.--Two experimental conditions were used referred to as the upstairs room and the downstairs room. They were Room A and B described in Experiment I.

Two lists were taken from Slamecka's 1962 study. The first list stated:

> So habitual become our expectations about symbols invariably possessing reference that we tend unconsciously toward such assumptions concerning every word.

The second list used for the interfering message stated:

> Communicators can exercise latitude in specifying meanings provided that such definitions correspond somewhat closely to customary usage.

The lists were presented serially for an interval of 3:1 with an intertrial interval of eight seconds. The list presented in the B room appeared in the window of a memory drum while the list in the U room was projected on the wall by a Kodak Carousel.

Procedure.--Ss were randomly assigned into a control group or one of the two experimental groups. The usual three-stage PI design was employed with the control subjects not learning during the first session. Half of the experimental Ss changed rooms between the first and second session while the other group did not. The two rooms were counterbalanced for the three groups as was sex. Accordingly, the male and female Ss were equally distributed in one of the following conditions: AAA, BAA, and -AA. Some of the groups had eleven female subjects while others had ten.

The list presented in session one (PI) was learned to a criterion of no errors. The list in session two was learned to a criterion of ten out of twenty correct responses. The interval between session two and three was thirty minutes and all Ss read an excerpt from Psychology Today entitled, "The Child As A Moral Philosopher." Immediately following the thirty-minute interval, the Ss practiced the list used in session two to an errorless criterion. Four subjects were run each day; one male and female in the morning and one male and female in the afternoon. The sequence of groups was randomly determined.

The instructions concerning the experiment were administered as follows:

"This is a learning experiment in which you will be asked to learn a list of words. The words will be presented serially, one at a time. It is very important that you follow the instructions carefully. We would also like to request that you not discuss the experiment with anyone else especially students who may participate later.

A list of 20 words will be presented to you. The words will appear, one at a time, through this projector on the wall (or in the window of this machine). Each word will appear for three seconds and will be followed immediately by the next word. There will be an interval of 18 seconds at the end of the list in which nothing will appear. Then as asterisk will appear signaling the beginning of the second trial. The words will then be presented as they were on the first trial.

It is necessary that you pay strict attention to each word as it is being presented. Your job will be to learn the list well enough so that you can say each word aloud just before it appears.

During the first time through you will just study the list. After the interval and when you see the asterisk, try to anticipate the first word. When you see the first word, try to verbally anticipate the second one. When you see the second word, try to anticipate the third and so on throughout the list.

Always try to get as many words as possible on each and every trial, regardless of whether you have anticipated all of them or only a few on previous trials. Don't worry if you can't remember as many on one trial as you have on previous trials, but do try to get as many as you can each time through the list. You are to learn the list as well as you can in the allotted time. If you think you know what a word will be, but are not sure, you are encouraged to guess. It is all right to guess since guessing will not count against you.

Are there any questions? (If there are questions, they are answered as succinctly as possible, referring directly to the instructions for clarification).

All right you will continue through a series of trials until I stop you. You may now begin to study the list."

At this point the machine was switched on and the subject began to learn the first list. After the initial learning, the subject was either switched to another room or asked to wait outside the same room while the list was being changed (approximately 1 minute).

Results

The number of correct responses on the first trial (NCFT) and the number of trials to criterion (TC) for the relearning session were analyzed. Since there was a difference between the groups in the number of trials required to reach criterion during OL, an analysis of covariance was used to control for the differences in trials during OL. During OL the no-change group required $\bar{X}=2.33$ the change group $\bar{X}=2.10$ and the controls 4.55. This difference was statistically significant, $F=19.02$ ($df=2,120$) $p<.001$. Table XXXII presents the analysis of covariance summary for the NCFT measure and Table XXXIII for the NT measure.

Table XXXII shows that there was not a significant group difference between the change, no-change and control groups. There was a significant treatment effect on the TC analysis, however, directional t tests were run to determine which mean differences were significant. The first comparison was between groups AAA and -AA and the difference was significant $t=1.96$ ($df=80$) $p<.05$. The second comparison AAA vrs. BAA was not significant $t=1.44$ ($df=80$) $p>.05$. The AAA $\bar{X}=1.55$, the -AA $\bar{X}=1.08$, and the BAA $\bar{X}=1.936$. The first comparison indicates that the procedure did produce observable PI for this measure and the second comparison shows that there was not a contextual change effect.

TABLE XXXII

SUMMARY OF ANALYSIS OF COVARIANCE FOR THE (NCFT)

Source of Variation	Degrees of Freedom	Mean Square	F Ratio
A (Groups; AAA, BAA, -AA)	2	22.53	2.61
B (Room for OL)	1	8.61	9.16 *
A x B	2	8.19	0.95
Error	119	8.61	

* $p<.01$

TABLE XXXIII

SUMMARY OF ANALYSIS OF COVARIANCE FOR (TC)

Source of Variation	Degrees of Freedom	Mean Square	F Ratio
A (Groups; AAA,BAA,-AA)	2	6.25	3.85 *
B (Room for OL)	1	19.77	12.21 **
A x B	2	2.11	1.30
Error	119	1.62	

* p<.05 ** p<.01

Experiment XIV - PI With Connected Discourse

Subjects.--The Ss in this experiment were 56 male, naive students presently taking the general psychology courses at the University of Notre Dame, Notre Dame, Indiana.

Apparatus.--The apparatuses consisted of the two environments described in Experiment VIII. The material to be learned consisted of three fairly difficult sentences. The sentences were similar to those employed by Slamecka (1961). In addition, a list of 20 randomly-determined, two-digit numbers were employed.

Experimental design.--The Ss were randomly assigned to four groups of 14 Ss each. A modification of the standard PI paradigm was used. and consisted of PL in which one full sentence was learned to 100% criterion, OL in which a second similar sentence was learned, followed by RL in which the latter sentence again was reacquired. For groups 1 and 2, PL involved a highly similar sentence to that learned during OL. For group 3, PL involved learning a sentence quite unrelated both in formal and contextual style. Group 4 learned a sequence of random numbers during PL.

Group 1 received PL in a room different than that in which both OL and RL occurred. Groups 2, 3, and 4 performed all three tasks in the same room. Conditions were counterbalanced across rooms and, where possible, across the sentences employed.

Procedure.--Each S received instructions pertaining to the task and apparatus, and then was given a warm-up trial of number guessing. The PL task was presented until S had learned it to a criterion of one perfect trial (or until 15 min. had elapsed in the case of number learning). Material was presented at a 3:3 sec. rate, with a 6 sec. intertrial interval. A 5-min. interval was inserted between PL and OL during which all Ss walked an equivalent distance. Original learning involved learning to one perfect recitation followed by a 15-min. interval in which E engaged S in causual conversation.

Results

Table XXXIV summarizes the number of trials to criterion for OL and RL for all four groups. Table XXXV summarizes the number of errors on trial 1 and trial 2 during the relearning task for all 4 groups. As seen, there was no evidence of a PI effect, per se, and, therefore, an analysis for contextual effects was not performed.

TABLE XXXIV

MEAN NUMBER OF TRIALS TO CRITERIA DURING ORIGINAL LEARNING (OL) AND RELEARNING (RL)

Source	$\bar{X}$ OL	$\bar{X}$ RL
Experimental Change	7.36	3.00
Experimental No Change	5.57	2.29
Control Unrelated PL learning	5.50	2.43
Control Digits during PL learning	9.93	2.71

TABLE XXXV

MEAN NUMBER OF ERRORS ON FIRST AND ON SECOND TRIAL DURING RELEARNING

Group	$\bar{X}$ Trial 1	$\bar{X}$ Trial 2
Experimental Change	10.64	3.43
Experimental No Change	8.64	4.00
Control Unrelated PL learning	8.36	2.64
Control Digits during PL learning	10.64	3.71

Experiment XV - PI With Connected Discourse

This experiment used the same design and procedure as described in Experiment XIV. The N was increased to 20 per group and only one control group was employed. The latter group did not receive learning during the PL session. The material for the PL task consisted of three 12-word sentences, these three sentences being made up of many of the words used in the PL sentences of the preceding study. The two environments were those of the preceding study. The words were presented using the serial anticipation method, and a procedure similar to that of the preceding study was employed. Group 1 received PL in Room 1, and OL and RL took place in Room 2. Groups 2 and 3 performed PL and the other two learning tasks all in the same room. Conditions were counterbalanced so that for half of each group, Room 1 was Room 2.

Each S received instructions pertaining to the task and apparatus. The PL task was presented until S had learned it to a criterion of one perfect trial (or until 20 min. had elapsed for the control group). The material was presented at a 2:2 rate with a 4-sec. intertrial interval.

Results

Table XXXVI represents the effect of the contextual variable with regard to several dependent measures. Again, there was not a significant effect. However, the experimental group who switched rooms between PL and OL evinced consistently fewer errors during relearning and evinced fewer trials to achieve 60% criterion but a further analysis was not performed because no PI had been demonstrated.

TABLE XXXVI

MEAN NUMBER OF ERRORS TO 60% AND 100% CRITERIA AND TRIALS TO 60% CRITERIA FOR CONTEXTUAL CHANGE GROUPS

Group		$\bar{X}$ Errors to 60%		$\bar{X}$ Errors to 100%		$\bar{X}$Trials 60%	
		Change	None	Change	None	Change	None
Change Between PL & OL	Change	25.3	23.7	61.1	44.1	1.60	1.70
	No Change	30.0	39.0	60.9	71.7	2.10	2.40
	Controls	55.9	39.7	52.5	70.5	1.90	2.60

All data was taken from the RL task

Experiment XVI - Pilot Study to Produce Inhibition Using Difficult and Unfamiliar Prose

Subjects.--Thirty-eight subjects enrolled in a course entitled The Psychology of Adolescence at Brigham Young University were used. All Ss present on the day of testing were used. The Ss had not previously participated in any verbal learning experiments. Because of defective booklets two Ss were discarded from the control group.

Materials and Measuring Instrument.--A 900-word passage about Heinz Remplein's theory of personality stratification was presented to both experimental and control subjects during original learning. Printed instructions told the students that this was a test of reading comprehension and that the readings would be followed by a test. Material for (OL) was placed in the first section of a booklet. The second section of the booklet consisted of 900-word passages used for (IL). Control subjects during the IL session received an excerpt from Robert Louis Stevenson's Kidnapped while the experimental subjects read a passage dealing with Oswald Kroh's developmental theory of stages and phases.

Both the Heinz Remplein and Oswald Kroh passages were copies almost directly from the appropriate chapters in Theories of Adolescence (Muuss, 1964). A selection of material ordinarily used in conjunction with the course was desirable because an attempt was made to produce a natural classroom learning situation with meaningful prose. These passages were selected because the theories were extremely obscure and unfamiliar to the Ss.

Section three in the booklet contained the recall test. The test consisted of twelve questions. Three questions dealt with the recall of names and two questions dealt with the recall of appropriate age for various stages of development. The remaining questions dealt with the recall of basic elements of Heinz Remplein's theory. A total of 27 points was possible. Each item on the scoring key was worth one point except for discussion questions which were weighted double. The scoring key was constructed prior to observing the data. The data was then blindly scored by a graduate assistant. At the top of the recall test the following information was requested: sex, approximate grade point average, and a rating of material difficulty during OL on a six point scale.

Procedure.--Upon entering the room on the day of the experiment, all subjects randomly were assigned to either an experimental or a control group. They were provided with written instructions which stated: "This is a test of your reading comprehension. The materials found herein are relevant to psychology and should be of interest to serious students in that field. The readings will be followed by a test over the material read. The E will keep you informed as to the sequence in which the various sections of this booklet are to be read. The sections are identified by letter (Section A, Section B, etc.). If you should complete a section before time is called, do not go on to the next section, but immediately start rereading the section completed. When the experimenter calls "time," place a letter in the left hand margin of the booklet even with the line you were reading. Use an "X" if it is your first time through the material or an "O" if it is your second time through the material. Remember: This is a test of reading comprehension, not speed, although you should try to complete as much of the material in each section as possible. When reading, try to say each word to yourself. Do not look ahead or go back to previous sections unless instructed to do so. Do not identify yourself by name or student number on this test booklet." Groups were identified according to the booklet they used. The subjects were then told to begin reading. They were given 7 minutes to read each section and then they were asked to complete the recall test in section III. No time limit was placed on completing the test in section C. Two proctors remained in the room and closely observed the subjects in order to insure that they would not return to the text of earlier passages when completing the recall test.

Results

The number of correct (R), incorrect (W), and R-W scores were recorded for each subject. To avoid negative numbers, a constant of fifty points was added to all the R-W difference scores. In order to check the adequacy of the random assignment and the comparability of the sample, the following data were obtained. In the control group there was 10 males and in the experimental group there was also 10 males. The approximate reported grade point average in the control groups was 2.4 and 2.2 for the experimental group. The mean rating of the difficulty of the material was 4.2 for the controls, and 4.3 for the experimental subjects. The control subjects read 1290 words during OL and the experimental subjects read 1260. On the basis of these criterion following random assignment it is concluded that the groups were very comparable. In order to test for the RI effects directional comparisons between the experimental and control groups were made on each of three measures. First, a comparison was made on the number of correct responses (R) during recall then the number of errors (W). Table XXXVII presents the data for these comparisons. A significant RI effect was obtained on each of the three measures and the material and procedure was considered sufficient to use in a later contextual change experiment.

TABLE XXXVII

MEANS AND t RATIOS BETWEEN THE EXPERIMENTAL AND CONTROL GROUPS FOR THE NUMBER OF RIGHT, WRONG, AND CORRECT MINUS WRONG RESPONSES

Variable	Experimental (RI) n=19		Control n=17		df	t Ratio
	$\overline{X}$	SD	$\overline{X}$	SD		
Number Correct (R)	7.58	3.82	11.18	6.70	34	2.01 *
Number Errors (W)	11.01	8.47	6.94	5.24	34	1.75 *
R - W + 50	46.58	10.44	54.23	7.28	34	2.52 **

*p < .05
**p < .01

Experiment XVII - Proactive Inhibition Classroom Material

Subjects.--The subjects were 160 volunteers from introductory psychology classes at Brigham Young University. These subjects had not participated in any verbal learning experiments.

Contexts.--Two learning contexts were used. The first (designated here as "D") was a basement room where learning took place in total darkness; only the material to be learned was lighted. The material was presented one line at a time (at an interval of 4 seconds per line) in the window of a memory drum. A light attached to the machine and shielded illuminated only the window. No other light source was present. A constant droning of a fan was present.

The S was seated in a regular classroom desk and the memory drum was on a low table about 1-2 feet in front of the S's face at about chin level.

The second room (which will here be designated at "U") was an upstairs room. It was a small (approximately 10 x 12) carpeted room painted pale green containing two tables and three chairs. An end table against one wall had a number of magazines and a potted plant on it. The other table was the one the S used for the learning. It was covered by a yellow tablecloth. Four text books, a small potted flower, and a desk lamp (high intensity) gave it a study atmosphere. The chairs were in three corners of the room. A soft light from a pole-type lamp lighted the room with a soft light and the desk lamp lighted the are of the table used for reading. Under one table was a tape recorder; and one realistic painting and a travel poster (Rome) decorated the walls. It was as much like a home-type study situation as we could make it.

The material was presented in a stenographers booklet with the same material typed on lines spaced about 1 1/2 inches apart. There were four lines on a page. The subject turned the pages every 16 seconds when he was told to by a taped voice. The presentation rate and material was the same for the memory drum.

Materials.--The materials were developed in a pilot study and were described in Experiment XVI. Kroh's theory was presented during PL and Remplein's during OL.

Groups.--Four conditions were used. Groups one received PL, OL, and RL in the same room and is designated AAA. Group two was the same as group one except there was a contextual change between PL and OL and is designated as BAA.

Group three was a control group, did not change context, and received the non-interfering reading during PL. It is coded as NAA. Group four had no session one and did not change contexts. Group four is coded -AA. Room, sex, and time of day were counterbalanced across the four conditions.

Procedure.--The procedure was held as constant as possible with every subject. The S was taken into one of the two rooms for the first session. Here he was seated and the experimenter left the room for one minute. This procedure was used in expectation that the S would be cognizant of his surroundings.

When the experimenter returned he asked the subject, "Did you volunteer for this experiment?" Then he was told, "This is a learning study," and asked not to discuss the experiment with other students. He was then given the directions for the first reading. "You are going to be presented with a passage which I would like you to read carefully. It will be presented on the page of this notebook (if in the upstairs room) or in the window of this machine one line at a time (if in the downstairs room)." PL included two readings of the material (List B or C). This was followed by a one-minute break in which the subject left the room and stood in the hall.

OL always consisted of two exposures to the material. It was read once the same way as in PL. The second reading was also a measure of learning. The same reading was presented but throughout the passage the S was required to make a choice between two words in 43 cases. In each case the correct word was the one that had appeared in the previous reading. The S said his choice aloud and the experimenter then gave him the correct answer.

RL started with a free recall post test. This consisted of seven questions over the OL material. Next a multiple choice test was given. For both tests the S gave his answers aloud. The relearning in session three consisted of the same two choice readings that were previously given at the end of OL.

Prior to session three was a six-minute interval during which time an interpolated task was completed. Ss were asked to read a short story in a popular magazine.

Four measures were analyzed: The number of correct responses on a free recall test was counted (FR), the score on a multiple choice (MC), the number of correct choices on the first relearning trial (NCFT), and the number of correct choices on the last trial of OL (NCOL).

Results

As a preliminary analysis the number of correct responses during the last trial of OL was analyzed (NCOL) to determine if the groups were comparable before the retention interval. Table XXXVIII presents this analysis.

TABLE XXXVIII

SUMMARY OF THE ANALYSIS OF COVARIANCE FOR THE NUMBER OF CORRECT RESPONSES ON THE LAST TRIAL OF OL

Source of Variation	Degrees of Freedom	Mean Square	F Ratio
A (Groups)	3	49.21	3.10 *
B (Room for OL)	1	39.01	2.46
A x B	3	28.82	1.82
Error	151	15.88	

* $p < .05$

Table XXXVIII indicates that the groups were not equal in OL. The two control groups had almost the same means $\bar{X}_{AA}$=35.02 $\bar{X}_{RAA}$=32.77. Because of this small initial difference between groups and analysis of covariance was used to analyze all the retention measures. The OL learning was the covariate.

Table XXXIX-XXXXI present the analysis of covariance for the FR, MC, NCFT scores.

TABLE XXXIX

SUMMARY OF ANALYSIS OF COVARIANCE FOR FREE RECALL

Source of Variation	Degrees of Freedom	Mean Square	F Ratio
A (Groups)	3	1.23	0.47
B (Room for OL)	1	3.43	1.31
A x B	3	.81	.31
Error	151	2.60	

There was not a significant main effect in any of these measures and, therefore, it is concluded that PI had not been produced and, therefore, the contextual change effect could not have been observed.

TABLE XXXX

SUMMARY OF ANALYSIS OF COVARIANCE FOR MULTIPLE CHOICE

Source of Variation	Degrees of Freedom	Mean Square	F Ratio
A (Groups)	3	3.04	0.32
B (Room for OL)	1	18.21	1.94
A x B	3	17.06	1.81
Error	151	9.38	

TABLE XXXXI

SUMMARY OF ANALYSIS OF COVARIANCE FOR NUMBER OF CORRECT RESPONSES FOR FIRST TRIAL OF RELEARNING

Source of Variation	Degrees of Freedom	Mean Square	F Ratio
A (Groups)	3	.11	1.47
B (Room for OL)	1	.0002	.00
A x B	3	.22	.22
Error	3	.08	

Summary Chapter of Project Findings

In this chapter the several experiments under the three areas of retention, retroactive, and proactive inhibition will be discussed separately. First, the retention experiments are considered, then the retroactive and proactive studies. In discussing each of these areas, a concise statement will be made which should integrate the various experiments and describe the basic conclusions. The last section of this chapter will point out the necessity for further research, and indicate the experiments which should be conducted first.

Because of the large number of experiments with varying materials and levels of learning, Table XXXXII was prepared so that the most satient characteristics and findings of the experiments could be compared simultaneously. Before examining the table, however, it may be helpful to mention that each experiment had a large sample: a total of 1000 Ss were tested individually. The large sample size, with subjects run individually to reduce uncontrolled variation, markedly increases the chances of obtaining statistical significance in each experiment. Those studies presented in Table XXXXII which are followed by a yes were significant at the .05 level of significance or higher. The table shows that a contextual change effect was found for retention, RI and PI in at least one experiment.

Retention

It appears that for nonsense syllables the contextual change retention effect only occurs when certain strengths of OL learning are present.

TABLE XXXXII

SUMMARY AND DESCRIPTION OF PROJECT FINDINGS

Experiment	Title	Materials	PI or RI Effect	Contextual Change Effect
I	Retention One Hour	Nonsense	--	Yes
II	Retention One Week	Nonsense	--	No
III	Retention Six Age Groups	Nonsense	--	Yes
IV	Retention	Connected Discourse	--	No
V	Retention	Classroom	--	No
VI	RI 100% OL Criterion		No	Not Tested
VII	RI 60% OL Criterion		Yes	Yes
VIII	RI	Connected Discourse	Yes	Yes
IX	RI	Classroom	No	Not Tested
X	RI	Classroom	Yes	Yes
XI	PI 60% OL Criterion	Nonsense	Yes	Yes
XII	PI 100% OL Criterion	Nonsense	No	Not Tested
XIII	PI	Connected Discourse	Yes	No
XIV	PI	Connected Discourse	No	Not Tested
XV	PI	Connected Discourse	No	Not Tested
XVI	RI Pilot to Produce Materials	Classroom	Yes	
XVII	PI	Classroom	No	No
Number of Positive Findings			6	6
Number of Negative Findings			6	4

For example, when a long interval such as a week elapses the association strength of OL learning is apparently so weak that reproducing the original context is not sufficient to significantly assist recall or changing the context can not significantly increase the already large retention decrement. However, an interesting question arises when inspection ot Tables I and IV show that the (NCFT) for 60% one-week interval Ss are about the same as the 100% one-hour interval. This suggests that the contextual effect in retention may not entirely depend upon the associative strength of the OL list but may also be related to the associative strength of the ambient contextual cues. In the situation discussed above, it seems probably that the recall of the contextual cues were also weakened during the one-week interval. Perhaps more important in regards to the contextual change effect on retention is the finding that in the experiments using connected discourse or classroom materials the contextual change effect was not found. This lends support to the contention that principles governing the learning and retention of nonsense syllables are not the same as those controlling more meaningful verbal materials. Please refer to Ausubel (1963, 1968, 1969) for the empirical support references and logic behind this assertion.

Retroactive Inhibition

In the RI experiments, the contextual change effect was found using all three types of materials. The RI experiments are probably the most significant achievement of this project. In every case where RI was first produced by the procedures, a contextual change effect in the predicted direction was found; Experiments VII, VIII, and X. In general, a change in the context for interpolated learning, ABA, resulted in performance more similar to control groups not receiving interpolated material. In Experiments XIII and X, the materials were connected with discourse and classroom materials which argue that the principles of verbal learning can be generalized to more ordinary materials and that the contextual change findings using nonsense syllables to more meaningful discourse are also applicable.

Proactive Inhibition

From the six PI experiments, only one demonstrated a contextual change effect. The reason for this small ratio is immediately obvious when one observes the PI of Table XXXXII. Only two experiments even produced PI and, of course, they were the only ones which could be tested. The remaining four were not tested because a contextual change effect was designed to reduce PI which assumes that there is some PI to reduce. Again this failure to produce PI supports the argument of these theories described in Experiment XVI, who maintain the RI and PI does not occur with ordinary materials. The fact that RI and PI have been produced with each of the three levels of materials in this project is of major importance itself and should be immediately investigated. However, simply producing PI and RI in some experiments is not adequate to describe the PI and RI phenomena to the level of precision required for further research and practical application.

Conclusions and Future Research

It is, therefore, concluded that the most pressing immediate task in this area is to investigate PI and RI using connected discourse and classroom materials. It does not seem efficient to proceed with only a small proportion of the experiments producing inhibition. However, the difficulties do not imply to the present authors that the contextual change effect is trivial. Instead, it seems that accounting for as little as 10% of the variance in retention decrement is a significant accomplishment when one considers the almost innumerable intra- and extra-organismic variables influencing learning and retention. Some Omegas run on the data in the various experiments, lead the principle investigator to conclude that approximately 6-12% of the variance is accounted for through contextual change effects.

While Underwood (1957) maintains that PI is the most pervasive form of interference in ordinary learning, it also seems to be the most difficult to experimentally produce, particularly as it relates to contextual change. A recent publication by Dallet and Wilcox (1963) may have provided the procedure through which more consistent PI can be produced and simultaneously investigated contextual change effects. Their general procedure required the Ss to learn several lists in the same context over a period of days to build up PI. Then he obtained strong PI and contextual effects when a contextual change was required.

Briefly it is concluded that despite several failures, a contextual change effect as predicted in the introduction was obtained for retention, RI and PI. In addition, the contextual change effect was obtained for nonsense, connected discourse, and classroom materials in the RI studies and for nonsense materials in the retention and PI experiments.

These conclusions, which are based on what appears to be the first systematic research program into the area of contextual change and forgetting, were drawn from a small number of experiments. Considering the obvious fact that ambient contextual stimuli surround almost all learning and retention, any measurable effect those contextual stimuli have would be of practical importance. It is, therefore, recommended that additional investigations be undertaken to more fully document the results obtained in this project and more fully identify the controlling variables. In addition, it seems even more urgent to investigate the prevalence and conditions which produce PI with connected discourse and classroom materials.

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